RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

PUBLISHED BY THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

VOL. XVII SEPTEMBER, 1931 No. 3

THE COMPARATIVE RADIOSENSITIVITY OF PHARYNGEAL TUMORS[1]

By HAYES E. MARTIN, M.D., Assistant Attending Surgeon, Memorial Hospital, NEW YORK, and OTTO H. PFLUEGER, M.D., SAN FRANCISCO, CALIFORNIA
(Formerly Resident Surgeon, Memorial Hospital)

From the Intra-oral Department. Service of Dr. Douglas Quick

THE specific histologic structure of a given tumor is generally considered the most reliable index to its radiosensitivity. This is ordinarily true, but the wide variation in radiosensitivity among histologically similar tumors indicates the significance of other factors not as yet discernible by microscopic examination. We have been impressed by the fact that tumors of certain anatomic locations will, in general, react similarly, despite their different histologic structure. One of the best examples of this observation is the pharyngeal cavity.

Pharyngeal tumors, in general, are more often radiosensitive than those of the adjacent oral cavity, intrinsic larynx, or esophagus. This fact has stimulated investigation from the histological standpoint with the result that such radiosensitive subgroups of epidermoid carcinoma as lympho-epithelioma and transitional-cell carcinoma have been differentiated as clinical and pathologic entities. These tumors occur most frequently in the pharynx and, according to percentage figures given by Ewing (1) and Quick and Cutler (2), comprise about 16 per cent of all pharyngeal growths. All writers stress the marked radiosensitivity of transitional-cell carcinoma and lympho-epithelioma as special characteristics of these groups, but we believe that this emphasis has obscured the fact that marked radiosensitivity is common to all pharyngeal tumors and is not entirely confined to any histologic variety. In support of this view, we submit the cases reported in this paper. These cases are chosen to illustrate that adult squamous carcinoma, and adenocarcinoma of salivary gland type of the pharynx may respond as well as or even better than certain of the more anaplastic varieties. This phenomenon can not be explained on a histologic basis and occurs most frequently in pharyngeal tumors.

The pharynx, for the purposes of this discussion, includes the nasopharynx, oral pharynx, and hypopharynx, and roughly extends from the posterior margin of the nasal septum down to the level of the ventricular folds (Fig. 1). It is separated from the oral cavity by a line drawn between the anterior pillars of the tonsils and thus includes the base of the tongue, epiglottis, and extrinsic portions of the larynx. Tumors of the oral surface of the soft palate commonly partake of this same radiosensitivity, while those of the pyriform sinuses resemble those of the esophagus in their radioresistance.

[1]Read before the Radiological Society of North America, at the Sixteenth Annual Meeting, at Los Angeles, Dec. 1 to 5, 1930.

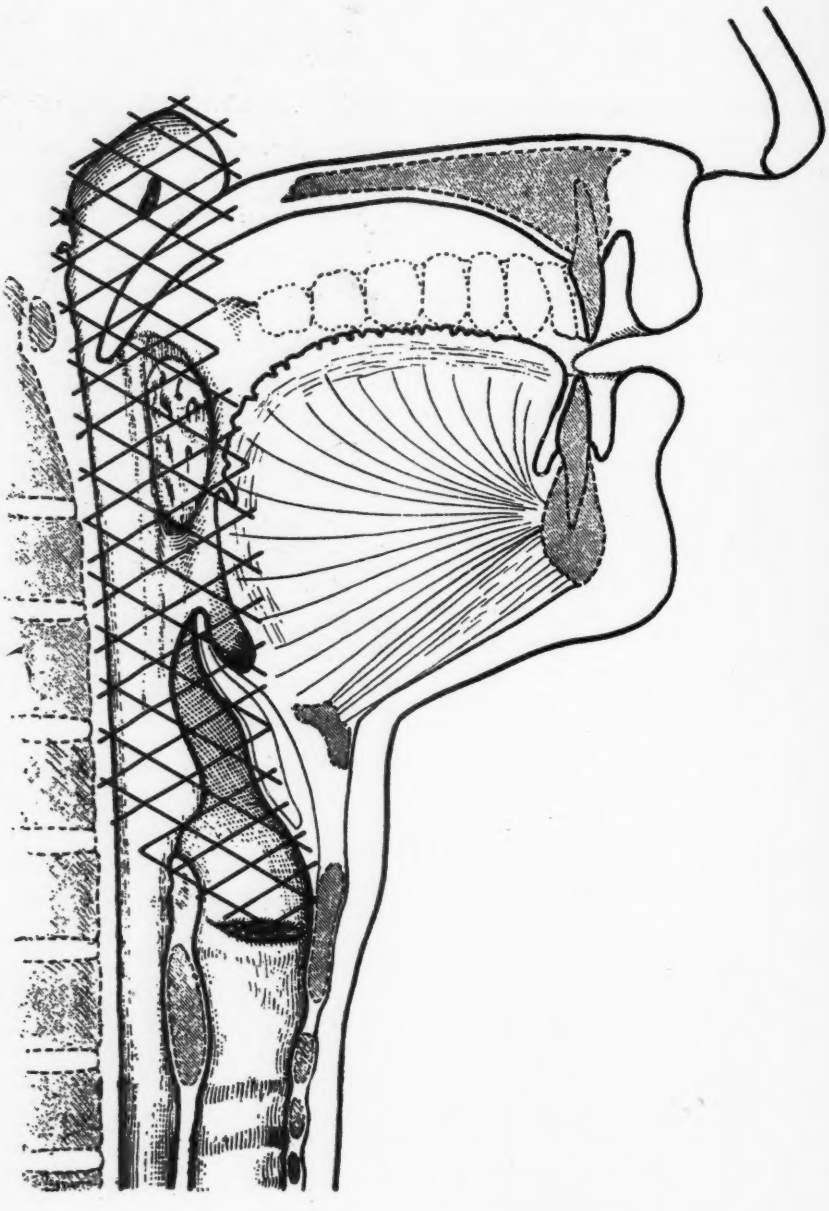


Fig. 1. The pharynx, for the purpose of this discussion, includes the nasopharynx, oral pharynx, and hypopharynx, and roughly extends from the posterior margin of the nasal septum down to the level of the ventricular folds. The cross-hatched portions indicate the regions from which radiosensitive tumors commonly arise.

Histologic study of tissues from the tongue at the junction of the anterior and middle thirds, the floor of the mouth adjoining the frenum, the soft palate, base of tongue just posterior to the vallate papillæ, anterior surface of the epiglottis, and pyriform sinuses does not reveal striking differences in fundamental make-up of the epithelium. The most that can be said is that the epithelium over the tongue, both dorsum and base, as well as the anterior floor of the mouth, shows a very flat, outer squamous zone some five or six cells in thickness, deeply staining with eosin. That of the dorsum of the tongue anterior to the vallate papillæ is thickest and here the epithelium approaches in character that of the skin. The histologic differences scarcely offer an explanation for the observed differences in average radiosensitivity of histologically similar tumors in these locations.

Radiosensitivity must remain an indefinite and relative expression until it can be defined in terms of the quantity (in units) of the radiant energy, which, if delivered within a tumor, will cause its destruction. One of us (H. E. M.) and Quimby (3, 4) have published our investigations on the lethal radiation dose of various intra-oral neoplasms. In these investigations, the term "tissue dose" was used to express the quantity of radiant energy reaching a point within tissue. Since, in clinical practice, radiations can not be made uniform in distribution throughout any volume, the tissue dose of a tumor mass was defined as of that point within it which received the smallest quantity of energy. For our unit of tissue dosage we used the skin erythema dose. (The r unit is not as yet applicable to all methods and types of irradiation.) The physical basis for tissue dosage measurement and the results of our investigations are fully described in the above-mentioned references, and we will mention only certain findings which are pertinent to the present discussion.

Fig. 2. Case 1. Adenocarcinoma of salivary gland type.

In a series of 48 cases, we found the lethal dose of intra-oral adult squamous carcinoma to lie between 6 and 10 S.E.D. (skin erythema dose). No case of adult squamous carcinoma of the oral cavity proper in this series was completely controlled by a tissue dose of less than 6 S.E.D. In the following cases of pharyngeal tumors, the histologic picture does not indicate a marked degree of radiosensitivity, and yet the immediate response was equal to and even more pronounced than in certain observed cases of anaplastic carcinomas. Such instances have been observed quite frequently, but it is often difficult to give definite tissue dosage figures as in the cases herein presented. We attribute such instances as favoring a regional influence in the determination of radiosensitivity. This regional influence probably depends partly upon a local similar-

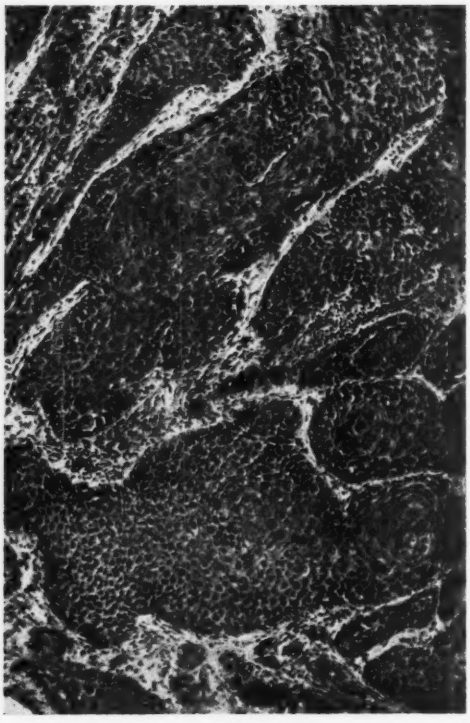


Fig. 3. Case 2. Squamous carcinoma, Grade 2.

ity in the tissues of origin and also upon the nature of the tumor bed. The cases presented below showed a high degree of radiosensitivity not evident in the histologic structure. We have chosen these as excellent examples, despite the fact that in all there was recurrence and a fatal termination. Since the treatment in these cases was palliative and by external irradiation only, the tissue doses are small and can be calculated quite accurately. In the more favorable cases with smaller primary lesions, we ordinarily also use interstitial irradiation and consequently greater tissue dosage. In such cases, high radiosensitivity is difficult to prove, even though it may exist.

Case 1. M. L. (No. 41,550), a female, aged 36, applied at Memorial Hospital in May, 1929. She gave a history of "throat trouble" of about two years' duration for which she had received numerous X-ray treatments with varying periods of complete symptomatic relief. Shortly before admission, she had become conscious of a mass in the throat.

Examination revealed a mass about five centimeters in diameter deeply infiltrating the base of the tongue just in front of the epiglottis. On both sides of the neck, anterior to the carotid bulbs, were groups of several nodes one to two centimeters in diameter. A biopsy was reported as "adenocarcinoma of salivary gland type" (Fig. 2).

The patient was treated by the radium element pack and over a period of twenty days received 32,000 milligram-hours at six centimeters distance to each side of the neck opposite the primary lesion. This irradiation has been calculated as producing a tissue dose of 1.6 S.E.D. to the midline of the pharynx.

About two weeks after the completion of the treatment, all palpable evidence of the tumor in the tongue and in the neck had disappeared, and she remained free from any sign of the disease for six months, when a local recurrence appeared, followed by neck metastases. Palliative irradiation was again applied, with only moderate success, and the patient succumbed about one year later.

Although the disease was not permanently controlled, the prompt and complete clinical regression of the bulky mass in the tongue, as well as the bilateral neck nodes, under a tissue dose of 1.6 S.E.D., demonstrates that this tumor was more radiosensitive than its histologic picture indicates.

The slide (Fig. 2) has been reviewed by Dr. Fred W. Stewart, whose report is as follows: "Adenocarcinoma of salivary gland type. The structure is that of solid and cystic areas—mainly areas of small cysts filled with mucin. In some areas the cysts are quite large, but in others they are smaller and the structure resembles that which is ordinarily described as cylindroma. There

is a great deal of dense hyaline connective tissue. Although this tumor appears less radioresistant than adult squamous carcinoma, there is no histological evidence of extreme radiosensitivity."

Case 2. A. F. (No. 40,520), a male, aged 40, applied at Memorial Hospital in March, 1929. He had noted "soreness" in the throat for about one year and difficulty in swallowing for about two months.

Examination showed an irregular, granular, ulcerated lesion on the posterior pharyngeal wall, extending from just above the free border of the soft palate down to about the level of the arytenoids. There was extension to the lateral pharyngeal walls and posterior tonsillar pillars. The vertical diameter of this lesion was at least six centimeters. Soft movable nodes two centimeters in diameter were palpable over the carotid bulbs on either side of the neck. A biopsy was reported as "squamous carcinoma, Grade 2" (Fig. 3).

The patient received 40,000 milligram-hours with the element pack at six centimeters' distance to each side of the neck directly opposite the lesion. This treatment was given over a period of fifty days. The tissue dose to the midline of the pharynx was 2.0 S.E.D. About three weeks after beginning treatment, there was a marked regression in size, and in about two months the lesion had apparently completely disappeared. About three months later, however, a recurrence was noted, which grew rapidly, and since the local and general tolerance would not permit heavy supplementary irradiation, the course was steadily downward, and the man died about three months later.

Although the disease was not controlled, the prompt regression and clinical disappearance of this tumor, which almost entirely covered the posterior pharyngeal wall, under a tissue dose of 2.0 S.E.D., indicated a radiosensitivity not usually found in squamous carcinoma, Grade 2.

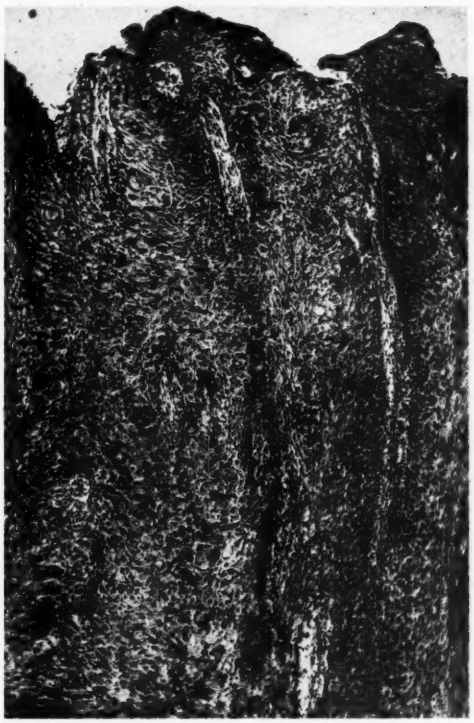


Fig. 4. Case 3. Papillary squamous carcinoma, Grade 1, radioresistant.

A review of the slide (Fig. 3) by Dr. Stewart is as follows: "Squamous carcinoma, Grade 2. Mucous membrane type without marked pearl formation. Although it does not appear markedly radioresistant, there is no histological evidence of extreme radiosensitivity."

Case 3. C. S., a female, aged 55, was admitted to Memorial Hospital Clinic in March, 1929. She had noted an obstruction to breathing about six weeks prior to admission.

Examination disclosed an ulcerated, granular mass about three centimeters in diameter on the posterior wall of the nasopharynx just back of the nasal septum. A biopsy was reported as "papillary squamous

carcinoma, Grade 1, radioresistant" (Fig. 4).

The patient was treated by the radium element pack at six centimeters' distance to either side of the neck and cheek opposite the primary lesion. She failed several of her appointments for treatment and received only 16,000 milligram-hours to one side and 8,000 milligram-hours to the other side over a period of six days. About three weeks after beginning this treatment, the pharyngeal mass had apparently completely disappeared. The patient was mentally deficient and could not be induced to accept treatment after the apparent relief of her nasal obstruction. Although she apparently remained free of disease for several months, a local recurrence developed and death ensued. The tissue dose to the primary lesion in this case has been calculated as being 0.6 S.E.D., and in our experience is the smallest dose to which adult squamous carcinoma has shown such a response. Regression under such a small dose is not always found even in lymphosarcoma.

A review of the slide (Fig. 4) by Dr. Stewart is as follows: "Fully adult squamous carcinoma, papillary in structure. There is no histological evidence of radiosensitivity."

Since all the cases presented above developed local recurrences, the tissue doses given were sublethal, but it will be agreed that these doses must have been nearly lethal to have caused such prompt and apparently complete regression. We have chosen these recurrent cases as better examples of radiosensitivity than others in which the growth was permanently eradicated by larger doses. If a neoplasm is permanently eradicated, it is impossible to say how much less dosage would have sufficed. In our experience, growths with similar histologic pictures are quite radioresistant if found elsewhere, as, for instance, in the oral cavity proper, where such striking regression of bulky masses under external irradiation has not been observed.

It is not within the province of this paper to enter into the discussion of methods of treatment, but it should be understood that we do not advise the attempt at cure of pharyngeal tumors in general by small doses of irradiation. The inaccessibility of the greater portion of the pharynx to direct visual and manual approach renders interstitial implantation of radon comparatively inaccurate. Undue conservatism is, therefore, attended by unintentional underdosage. By external irradiation, the limit of tolerance is the production of tissue doses about 3 to 4 S.E.D. in twenty days to the midline of the pharynx. Unfortunately the lethal dose of many pharyngeal tumors is above this figure.

SUMMARY

Tumors of the pharynx are often more radiosensitive than their histologic counterparts of the adjacent oral cavity, intrinsic larynx, or esophagus. This quality is common to all pharyngeal tumors and is not a special characteristic of such well known histologic varieties as lympho-epithelioma and transitional-cell carcinoma, which are also most commonly found in the pharynx. This phenomenon can not be explained on the basis of the histologic structure.

REFERENCES

(1) Quick, D., and Cutler, M.: Transitional-cell Epidermoid Carcinoma, a Radiosensitive Type of Intra-oral Tumor. Surg., Gynec. and Obst., 1927, XL, 320.

(2) Ewing, J.: Lympho-epithelioma. Am. Jour. Path., March, 1929, V, 99-107.

(3) Martin, H. E., and Quimby, E. H.: Calculations of Tissue Dosage in Radiation Therapy: Preliminary Report. Am. Jour. Roentgenol. and Rad. Ther., February, 1930, XXIII, 173-196.

(4) Idem: Calculations of Tissue Dosage in Radiation Therapy: A Second Report. Am. Jour. Roentgenol. and Rad. Ther., April, 1931, XXV, 490-503.

DISCUSSION

Dr. Sanford M. Withers (Denver, Colorado): I believe that the greatest problem

in radiation therapy to-day is the study of radiosensitivity of cells. It is a thing that we have come here to discuss and learn about in one way or another—the radiosensitivity of cells. Every accurate observation of the behavior of a particular cell will help solve this problem. Let us have more of it. I believe that it is possible for each of us to make a practical application of this study in his own practice, and, further, we should tell others as much as we can of this work. If we would all *thoroughly* study the sections of the malignancies we treat, trying to fix in our minds the histologic and histogenetic picture presented, we could arrive at a fairly definite idea of the radiosensitiveness of the common types of carcinoma. When you have observed the reaction of a given growth—four or five or a dozen times with a given amount of radiation—it is possible to conclude that it will react in nearly the same way in the next case of like growth.

In this manner it is possible to govern one's treatment to some extent by the pathology presented and in some instances to give a more definite prognosis than formerly.

The radiosensibility of a cell depends upon the embryological origin—the degree of differentiation, the metabolic rate, the presence of ionizable protoplasm or secretory products within the cell. The radiosensitiveness of a tumor depends upon the above factors in addition to the character of the stroma, blood supply, infiltration with phagocytic cells, and the presence or absence of secondary infection. In addition to these factors, there are other unknown cellular characteristics that also determine radiosensibility. No one understands all of these characteristics, but any one of us may come to a better understanding of the treatment of cancer by more thorough study and observation of the pathology presented.

Dr. W. E. Costolow (Los Angeles): There are several facts cited in this paper which many of us have undoubtedly observed but which up until this time no one satisfactorily has attempted to explain. I think the anatomical variations in radiosensitivity alluded to in this paper can be verified if we compare some of the results we have obtained in the treatment of growths in the intrinsic larynx with those obtained in treating growths in the extrinsic larynx and pharynx. The growths in the intrinsic larynx have appeared much more radioresistant even though structurally they have appeared similar to some of the growths in the pharynx which have been definitely radiosensitive. I was recently much impressed by one case of extensive pharyngeal growth in which no attempt was made to treat by interstitial radiation, but only palliative treatment by external radiation was carried out. This case presented a Grade 1 growth which completely disappeared. We have never observed this in a Grade 1 growth in the oral cavity. I think the authors are to be complimented upon their original observations.

EFFECT OF ROENTGEN RADIATION ON SOLUTIONS OF TYROSINE, PHENOL, AND TRYPTOPHANE

By WILHELM STENSTROM, PH.D., and ANNE LOHMANN, M.A., MINNEAPOLIS
From the Laboratory of Biophysics, University of Minnesota

IN a preceding article (1) we have described how the effect of roentgen radiation on weak aqueous solutions of colored substances was studied in our laboratory. The same general arrangements have been used for the study of the effect on some other compounds. The amount of radiation absorbed by the solutions was also determined in the same manner as before, and was found to be about 8 kilo-roentgens per hour.

Tyrosine was chosen as one of the first substances to be studied because of its relatively simple configuration and its sensitivity to certain quantitative tests. For the first experiments Folin's phenol reagent (molybdate method) (2) was used to determine how much tyrosine was destroyed by the radiation. The tyrosine was extracted and purified by one of us (A. L.). The results of these experiments were published in 1928 (3). It was found that the total change produced by the radiation, as measured in this way, was proportional to the dose absorbed by the solution of the tyrosine when this was varied from 1.0 mg. to 0.02 mg. per c.c. of solution. Some measurements with tyrosine from the Phanstiehl Company have since been carried out. A straight line relation between the roentgen dose and the amount of the tyrosine changed, as determined by the molybdate method, was again obtained. The values were, however, slightly though consistently smaller than before. It is possible that substances produced by the radiation may also contribute to the color reaction utilized in the molybdate method, which, therefore, may not give the exact amount of tyrosine disappearing. More tyrosine should then have been affected than the measurements indicate. Although the same objection may be made to other tyrosine methods it seemed advisable to use one other test for comparison. Samples from the same tyrosine solutions were, therefore, examined both with the molybdate reagent and Millon's reagent (2). The latter indicated a greater change than the former, *e.g.*, 17 per cent against 13 per cent in one experiment.

It is difficult to determine what changes are produced by the radiation. Perhaps intermediary products are formed, which, again, are attacked and split up. They may, therefore, be present in very minute quantities and would not be easy to detect, when it is considered that the original concentration of the tyrosine was only 0.02 mg. per c.c. of solution. Perhaps different tyrosine molecules are changed in different ways; some may be aggregated to condensation products, others may be decomposed. It seemed probable that ammonia would be given off, and we tried to determine if such were the case. Fifty c.c. of a 0.02 per cent solution of tyrosine in 1 per cent H_2SO_4 was irradiated for 30 hours. A test for ammonia in this solution with Nessler's reagent was positive, but the color produced might be due to traces of other substances (*e.g.*, formaldehyde or hydroquinone). One-half of another sample irradiated for 65 hours was used for an amino acid determination (4) and it showed a 9 per cent loss of amino acid when compared with the unirradiated solution as a standard. The other half was extracted with permutit and tested with Nessler's reagent, and gave a color which indicated ammonia. A 100 c.c. sample of the same tyrosine solution was irradiated for 68 hours and divided into two parts; one-half was then aërated into 2 c.c. of 1 N HCl

solution which was then Nesslerized and compared with a 0.1 mg. nitrogen standard also containing 2 c.c. of 1 N HCl. The reading corresponded to 0.06 mg. N. The other half was aërated into 1 c.c. acid digestion mixture and again the reading corresponded to 0.06 mg. N. We also aërated a sample of the unirradiated tyrosine and tested it in the same way. A reading approximating 0.01 mg. N was obtained. Undoubtedly the tyrosine solution contained this trace of ammonia originally. We always used a standard containing all the solutions used in the preparation of the sample, thus compensating for all the ammonia except that present in the tyrosine sample. As the blank on the unirradiated tyrosine gave approximately 0.01 mg. N, this should be subtracted and the final result would be 0.05 mg. N produced by the irradiation. This method does not give accurate quantitative values on account of the deviations from the standard method (5) but shows that ammonia was produced by the irradiation.

These tests indicate a loss of about 0.05 mg. N, corresponding to a 6.5 per cent loss of amino acid as compared to 9 per cent in the above amino acid determination.

Instead of investigating the tyrosine products any further, we considered it of advantage to find out first if some other related substances were influenced by roentgen rays. Tryptophane was dissolved in water and made up to a solution of 0.02 mg. per c.c. in 0.04 N.H_2SO_4. This solution was divided into different tubes which were irradiated for varying lengths of time. The percentage of decomposition was measured by the molybdate method, using the unirradiated solution as a standard. The values obtained are given in Table I. Evidently the decomposition is a little faster in the beginning than later on. A slight concentration of intermediary products might explain this decrease in the rate of change. In order to test for ammonia it would be necessary to irradiate a long time and, during that time, the spontaneous decomposition of tryptophane would be considerable. It would, therefore, be very difficult to find if any discernible amount of ammonia was given off due to irradiation, so this was not tried.

TABLE I.—DECOMPOSITION OF TRYPTOPHANE

Time	Total decomposition (%)	Average decomposition per hour (%)
0 hr. 59 min.	7	7
1 " 49 "	11	6
2 " 9 "	9	4
2 " 57 "	12	4
3 " 53 "	14	3.6
3 " 55 "	15	3.8
4 " 47 "	17	3.6
5 " 0 "	17	3.4
5 " 54 "	19	3.2
6 " 27 "	20	3.1
6 " 44 "	18	2.7
7 " 17 "	21	2.9
8 " 35 "	24	2.8
9 " 40 "	27	2.8

It also seemed advisable to study the radiation effect on a simpler compound, such as phenol. Kahlbaum's synthetic phenol was made up in an aqueous solution of 0.02 mg. per cubic centimeter. The molybdate method was used both directly on irradiated samples and on the distillates of irradiated samples. The phenol solutions turned slightly brown when irradiated. This color remained in the residue when the phenol was distilled over. The irradiated samples were always tested against the unirradiated samples of the same solution. Some of the samples were distilled over an open flame and some were distilled under vacuum at 90° C. Both methods when tested on unirradiated solutions gave a yield of 98 per cent or more. The results are given in Table II. Approximately a straight line relation between the dose and the amount of phenol disappearing is obtained whether the phenol is distilled or not before the measurements, but the values obtained from the distilled phenol indicate a much greater decomposition. Evidently either some substance is produced which stays in the residue and

which gives a color reaction with the molybdate reagent or a definite amount of the phenol is occluded, depending upon the amount of residue. When the residue was tested with the molybdate reagent, it also gave a decided color reaction. An undistilled sample gave 42 per cent still present after irradiation, whereas a distilled sample gave 26 per cent and the residue 11 per cent, a total of 37 per cent for the same amount of radiation.

TABLE II.—DECOMPOSITION OF PHENOL

Time	Change in percentage Undistilled	
2 hrs. 35 min.	9	
3 " 27 "	11	
4 " 21 "	14	
6 " 20 "	21	
7 " 39 "	25	
9 " 32 "	43 (?)	
		Distilled under vacuum (%)
2 " 32 "	8	19
3 " 38 "	19	25
5 " 25 "	22	34
7 " 52 "	30	44
14 " 46 "	52	61
		Distilled over open flame (%)
0 " 28 "	0	0
0 " 45 "	2	5
1 " 12 "	3	8
1 " 24 "	4	9
1 " 43 "	5	11

If the color reaction in the residue is produced by decomposition products, then the measurements on the distilled solutions ought to give the most reliable values of the amount of phenol affected by the radiation. From these values the number of molecules changed per pair of ions figures out about ½ (M/N). The possibility that some substance is produced that also gives the molybdate reaction indicates that a similar thing may happen to tyrosine, and more of the tyrosine, then, it seems, should be destroyed by the irradiation than can be discerned by the molybdate method which was used in the first experiment.

SUMMARY

A study of the effect of roentgen rays on tyrosine in aqueous solutions has been published in a previous paper (3). The investigation has been continued and similar results were obtained when the molybdate method was used to determine the amount of change. Millon's method gave higher values. As the products formed might influence the color, the amount of tyrosine changed may be greater than either one of the two methods indicate. It was found by means of a combination of several kinds of tests that ammonia was given off from the tyrosine as a result of radiation.

The effect of roentgen radiation on tryptophane was tested with the molybdate method and a change of the same order of magnitude as that of tyrosine was found. The change, however, was faster in the beginning of the irradiation.

Phenol was also irradiated. The irradiated samples were tested with the molybdate method, both directly and after distillation. Both series of measurements indicate a direct proportionality between the rate of change and the roentgen-ray dose. The distilled samples indicate, however, a much larger change than the undistilled sample. Using the value obtained after distillation, M/N figures out to be approximately ½.

BIBLIOGRAPHY

(1) Stenstrom, Wilhelm, and Lohmann, Anne: Radiology, March, 1931, XVI, 322.
(2) Folin, O., and Ciocalteu, V.: Jour. Biol. Chem., June, 1927, LXXIII, 632.
(3) Stenstrom, Wilhelm, and Lohmann, Anne: Jour. Biol. Chem., October, 1928, LXXIX, 673.
(4) Folin, Otto: Jour. Biol. Chem., April, 1922, LI, 393.
(5) Folin, Otto, and Macallum, A. B.: Jour. Biol. Chem., June, 1912, XI, 523.
Folin, Otto, and Bell, Richard D.: Jour. Biol. Chem., March, 1917, XXIX, 329.
Folin, Otto, and Denis, W.: Jour. Biol. Chem., September, 1916, XXVI, 486.

THE ROENTGENOLOGIC STUDY OF PULMONARY METASTATIC GROWTHS[1]

By B. R. KIRKLIN, M.D., Section on Roentgenology, The Mayo Clinic, and HAROLD C. OCHSNER, M.D., Fellow in Roentgenology, The Mayo Foundation, ROCHESTER, MINNESOTA

IN 1860 Bristowe, in an address before the London Pathological Society, called attention to the fact that metastatic lesions are often found in the lungs, secondary to malignant conditions elsewhere. He stated that these lesions are capable of secondary degeneration and infection, thereby simulating many pulmonary diseases.

Clinical diagnosis of metastatic lesions of the lungs was extremely infrequent, however, prior to the discovery of the roentgen rays. This was due partly to the fact that such lesions were not sought for, but chiefly to the infrequency of characteristic physical signs. Certain it is that the extended use of roentgen rays in the diagnosis of pulmonary conditions has changed the previous conception that secondary pulmonary tumors are not common.

The first reported case in which roentgen rays were shown to be of value in the demonstration of a pulmonary metastatic lesion was that of Leo, reported in 1898. A boy, aged 10 years, who had been operated on for a sarcoma of the knee, exhibited the clinical manifestations of an organic pulmonary disease. Because of the patient's severe dyspnea, and the long exposures then necessary, roentgenography was not successful, but roentgenoscopy demonstrated the lesions. This method of approach proved to be far superior to ordinary clinical methods. At necropsy it was found that the lesions had been accurately localized by fluoroscopy; it had not been possible to elicit the physical signs by auscultation over the thorax.

Following this observation there was a long silent period. There are no available reports of the roentgenologic demonstration of pulmonary metastasis until 1909, when Arnsperger described the characteristics and the development of the lesions as seen by roentgen rays. Following this there was renewed interest in this study, and many reports have been written. The comparative paucity of reported cases may be explained by the fact that they are deemed too common to be of interest, or that, since the condition is terminal, the primary growth is not sought, and as a consequence its presence is never proved.

In a study of 71 cases, Moore and Carman found that the primary tumors might be found in the breast, thyroid gland, kidney, suprarenal gland, lung, larynx, esophagus, uterus, prostate gland, testis, sigmoid, in the soft tissues of the hand, arm, shoulder, leg or thigh, in the neck, face or hard palate, and in abdominal or pelvic masses, the nature of which could not be determined. In 20 cases, 28 per cent of the total number, the primary tumor was in the breast. This agrees with Warfield's observation that secondary carcinoma of the lung occurs in about a third of cases of carcinoma of the breast.

Dietlen demonstrated pulmonary lesions secondary to sarcoma of the testis and bones, and secondary to hypernephroma, chorionepithelioma, malignant goiter, myosarcoma of the uterus, carcinoma of the breast and carcinoma elsewhere. He, too, found that carcinoma of the breast has the greatest tendency to produce pulmonary metastasis.

Hamman concluded that, of carcinomas that metastasize to the lung, tumors of the

[1]Abridgment of thesis submitted by Dr. Ochsner to the Faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of Master of Science in Radiology, 1930.

Submitted for publication March 3, 1931.

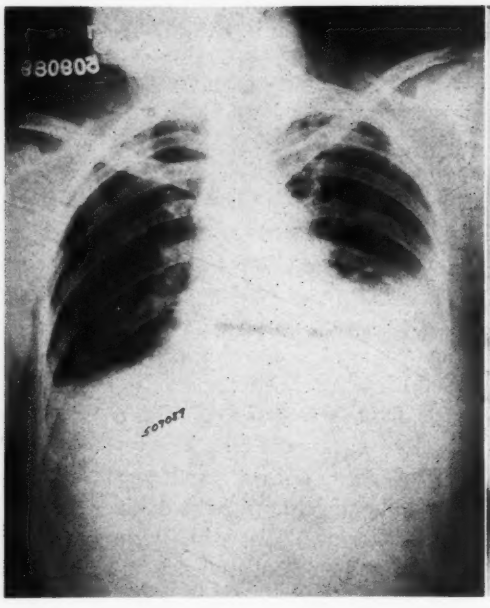


Fig. 1. Primary interest, here, is in the pleural reaction in the bases.

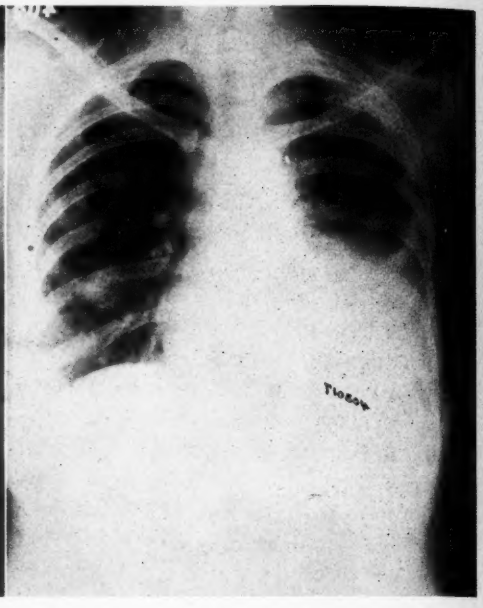


Fig. 2. Primary interest, here, is in the collection of fluid at the base and the left side.

breast and kidney are clinically the most important. Secondary sarcoma of the lung is less common than carcinoma, but the proportion of sarcomas which metastasize to the lung is greater. He found that carcinoma of bone and melanotic sarcoma almost regularly metastasize to the lungs. Burt, on the contrary, felt that metastasis of sarcoma from the extremities to the lungs is comparatively rare.

Hirsch expressed the belief that every type of visceral malignancy may produce pulmonary metastasis, and that no inference regarding the extent, duration, or nature of the primary growth can be drawn from the pulmonary lesion.

Karrenstein, and later Adler, found that primary malignant newgrowths of the lung are more common than benign growths, and comprise about 1 per cent of carcinomas in general. Blankenhorn stated that in cases of multiple metastasis the lungs escape more frequently than they are involved.

Kerley's simple explanation of the usual appearance of these lesions seems adequate. When a small group of cells is implanted in the lung, the cells begin to grow in the line of least resistance; in the lung the resistance is slight and uniform in all directions, and as a result the lesion becomes circular or ovoid. In their growth the new cells do not deeply invade the parenchyma of the lungs, but push it in front of them. As a result, the nodules become embedded in the lung like foreign bodies, and unless there are many they do not give rise to pulmonary symptoms. Chaoul cautioned that the fact that there are single, sharply circumscribed structures need cause no doubt as to the nature of the disease, for with progress the smaller nodules flow together into expanding regions of increased density.

Metastatic involvement of pulmonary structures may occur by direct extension or by hematogenous or lymphogenous dissemination. It has always been maintained that

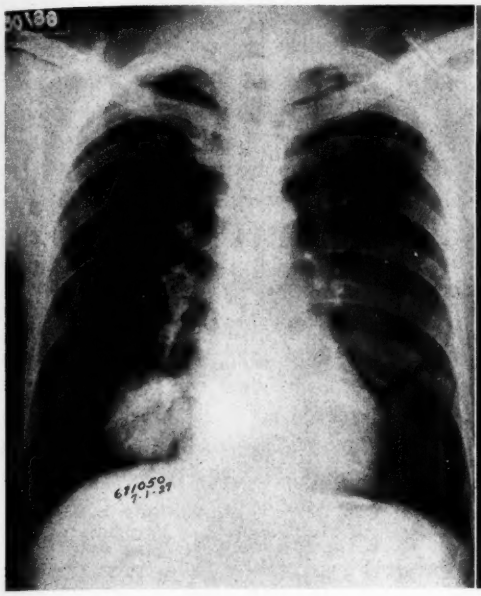


Fig. 3. Rapid growth of pulmonary metastatic lesion. This roentgenogram was made five months after removal of the right testis for malignant tumor.

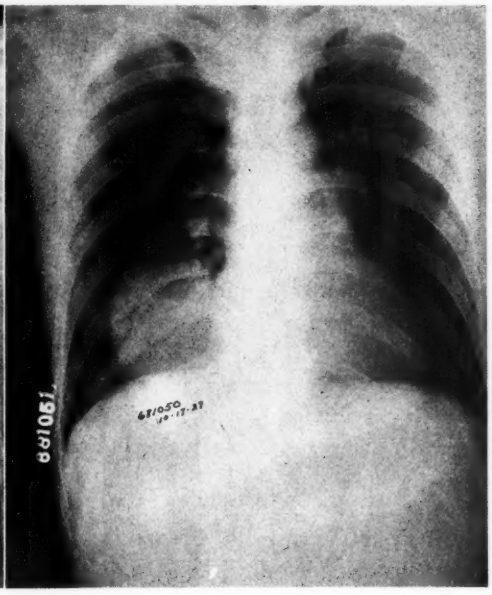


Fig. 4. Same case as Figure 3, three months later.

the dissemination of metastatic growths from sarcomas and mixed organoid tumors is by way of the blood stream, whereas the dissemination of carcinoma is generally by lymphatic permeation. Jackson said that in sarcoma the lungs play an analogous part, as a filter, to the regional lymph nodes in carcinoma; the metastasis in carcinoma travels by way of the lymphatic channels instead of the blood stream. Crane averred that one avenue of invasion is from the upper part of the peritoneal cavity, through the central tendon of the diaphragm, into the mediastinum, and thence to the lungs. Hamman felt that carcinoma of the stomach may extend through the diaphragm to the overlying lung. We shall not enter further into consideration of whether the lymph stream or the blood stream is the method of choice in indirect extension.

Before the perfection of surgical methods for removal of carcinoma of the breast, extension to pulmonary structures was seen more frequently than it is seen now. Moreover, subsequent exudation is now seen somewhat less frequently in this condition.

Attempts occasionally have been made to identify the primary lesion from a study of the size, shape, and distribution of the secondary pulmonary nodules. Beck stated that pleuritic effusion is more common in the presence of sarcoma than in the presence of other growths. Chaoul felt that the circular form of lesion is characteristic of sarcoma, and that in carcinoma the pulmonary fields are usually strewn with speckles, like a glass plate covered with wet snowflakes. Dietlen said that a large number of metastatic nodules speaks for sarcoma (bone, testis) rather than for carcinoma. Hirsch stated that sarcoma metastasizing to the lungs most often produces an extensive shadow in the lower pulmonic field, single, and having more or less rounded form. He added that in the late stages of the disease, carcinoma may give the same appearance. Kerley, on the other

hand, said that the nodules in metastatic sarcoma vary from the size of a pea to that of a marble. In his recent book, Sante wrote, "Carcinomatous infiltrations are small, more irregular in outline, and less uniform in density than those produced by sarcoma. Sarcoma metastases are usually sharply outlined spherical nodules much larger than ordinary infiltrations of carcinoma." However, he called attention to the fact that it is not possible to distinguish between the two.

For purposes of classification it would be well to consider separately lesions of the parenchyma, lymph nodes, and pleura. Lesions of the parenchyma may be nodular, and may be miliary or large; they may involve the greater portion of one lobe, or they may be infiltrative, with the appearance of wet snowflakes described by Chaoul. When the lymph nodes are involved, there may be hilar or mediastinal enlargement. Evidence of metastasis to the pleura is seen most often as pleurisy with effusion, which cannot be distinguished, by roentgenologic evidence, from pleurisy with effusion due to other causes.

Pulmonary metastatic lesions can be, and usually are, found by roentgenologic examination before there are demonstrable clinical symptoms. In fact, the roentgenologic demonstration of secondary pulmonary neoplasm may be the only evidence of disease, and the clinician is often severely taxed to find the hitherto unsuspected primary lesion. Dyspnea is the first, most constant, and the most progressive symptom, according to Robey. In the series of cases, roentgenologic features of which are to be presented, cough was the most common symptom; it was noted in 24, approximately 10 per cent of the total number. It was often dry, hacking, and unproductive. Dyspnea was almost equally common, and was followed in order of frequency by pain, hemoptysis, night sweats, and cyanosis.

Our problem has been to demonstrate the roentgenologic characteristics of the metastatic pulmonary lesions found in cases in which the nature of the primary lesion has been demonstrated definitely by histologic examination. For this purpose a series of 860 cases was studied, in which the diagnosis of pulmonary metastasis was made at postmortem examination, or on roentgenologic examination. One hundred and ninety of these cases were excluded from the present series because roentgenologic examination of the thorax had not been done in life. These were terminal cases; the patients were considered too ill to undergo examination, and they died shortly after admission to the hospital. In 404 cases, metastatic lesions were found at the patients' first admission to the clinic, before any surgical measures had been taken. Moreover, in these cases there was, of course, no surgical intervention. Since it could not be proved definitely that the primary lesion was that noted on clinical examination, these cases were excluded. Of the remaining series of 266 cases, the roentgenograms could not be found in 62, decreasing the total number finally considered to 204.

Table I shows the incidence of roentgenologically demonstrated pulmonary metastatic lesions as we have found them. The decided prominence of secondary involvement from carcinoma of the breast is notable. The average age of these patients can be seen to correspond to the usual age of incidence of the various primary tumors.

In its time relationships, the pulmonary metastatic lesion followed no rule. There was extreme variation in the duration of time between removal of the primary tumor and the development of its secondary manifestations. A considerable variation existed in the time which expired between roentgenologic demonstration of the pulmonary lesion and the death of the patient. Despite a negative roentgenogram at the time of surgical intervention, metastasis was sometimes

demonstrated a few weeks after the operation. Several cases were studied in which metastatic pulmonary lesions were found seven years after operation, in which no new primary lesion could be demonstrated. Although one case was noted in which death did not occur until six years after demonstration of definite pulmonary newgrowths, and several patients lived from two to five years, the average time from the demonstration of metastasis to the death of the patient was less than six months. Attempts to inhibit the progress of the secondary lesions by the use of roentgen rays or radium were singularly discouraging. Table II shows the average duration of time from operation to the time of roentgenologic demonstration of pulmonary lesions, and from this to the death of the patient.

Since metastatic lesions secondary to carcinoma of the breast are most common, they will be considered first. Of the 90 cases (Table I), there was no demonstrable parenchymal involvement in eleven, 12 per cent of the total number. Of the remaining 79 cases, in 66 (83 per cent) the lesions were bilateral. In 17 per cent of the 79 cases only unilateral involvement could be found, and there was a slight predominance of lesions of the right side. In 28, 35 per cent of these 90 cases, there was an accompanying pleuritic exudate on one side or both sides. There was mediastinal involvement in 6 per cent, and definitely increased hilar infiltration in 39 per cent. The parenchymal lesions were of the infiltrative type in 46 per cent; 88 per cent were of the miliary type. Thus, although there was probably nothing characteristic of the parenchymal lesions, the frequency of pleural involvement, with or without the former, leads one to feel that in many instances secondary involvement from carcinoma of the breast is the result of direct extension from the original lesion.

The accompanying illustrations demonstrate the typical pleural involvement in this condition. In the first case (Fig. 1) there was no parenchymal lesion other than a healed lesion of tuberculosis in the left apex. There was slight bilateral hilar infiltration, but the predominant lesion was the pleural reaction in the bases. In the third case (Fig. 2) there were the large nodular lesions which are found with greater rarity than the other conditions named. There was a considerable collection of fluid at the base of the lung on the left side, with partial col-

TABLE I.—INCIDENCE OF ROENTGENOLOGICALLY DEMONSTRATED PULMONARY METASTATIC LESIONS

Primary tumor	Cases	Average age, years
Carcinoma of breast	90	48.6
Epithelioma of cervix	13	40.6
Carcinoma of body of uterus	1	67
Sarcoma of body of uterus	2	60.5
Cystadenoma of ovary	5	50
Tumor of testis	15	27.5
Carcinoma of prostate gland	2	58.5
Epithelioma of urinary bladder	2	58
Epithelioma of scrotum	1	38
Carcinoma of large bowel and rectum	13	48.8
Carcinoma of stomach	3	57
Carcinoma of kidney	11	53
Carcinoma of thyroid gland	8	49.3
Sarcoma of bone	3	20
Fibrosarcoma of bone	4	39.8
Endothelioma of bone	2	25
Melano-epithelioma	13	50
Fibrosarcoma of soft parts	8	43
Squamous-cell epithelioma	8	56.3

TABLE II.—TIME RELATIONSHIPS INVOLVED IN PULMONARY METASTATIC LESIONS

Primary lesion	Time from removal of primary tumor to roentgenologic demonstration of pulmonary metastasis, months	Time from roentgenologic demonstration of pulmonary metastasis to death of patient, months
Tumor of testis	18	3.66
Papillary cystadenoma of ovary	66	1.5
Epithelioma of cervix	13.6	5
Sarcoma of body of uterus	28.5	7
Carcinoma of thyroid gland	14.4	9.9
Carcinoma of kidney	19.5	19
Carcinoma of breast	20.7	7.5
Carcinoma of large bowel and rectum	4.8	9
Fibrochondrosarcoma of bone	4	7.66
Sarcoma of bone	18	1
Squamous-cell epithelioma	4	5
Superficial fibrosarcoma	13	4.66
Melano-epithelioma	14.5	6.66

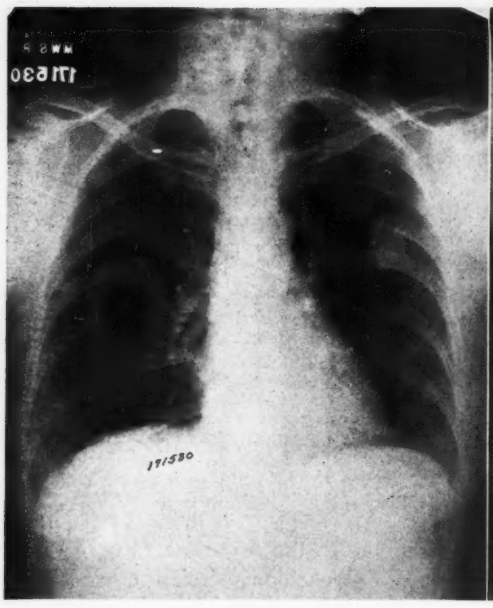


Fig. 5. Circumscribed, nodular, pulmonary lesions secondary to epithelioma of uterine cervix.

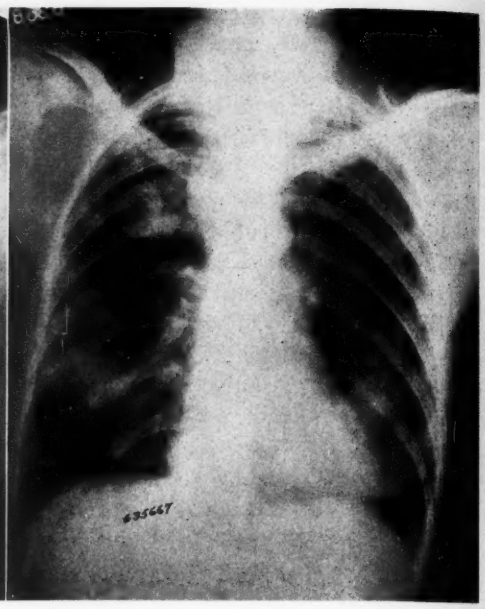


Fig. 6. A different case, of same kind as Figure 5, further advanced.

lapse of the left lung. The comparatively slight cardiac displacement is worthy of remark; instead of contralateral displacement, displacement of the heart toward the involved side is often noted.

The next in frequency of incidence in this series was metastasis from malignant growths of the male or female generative tract. There were 15 cases of testicular tumor, the microscopic classification of which will not be considered. There were definitely circumscribed parenchymal pulmonary lesions in all of these; 11, 73 per cent of the 15, were bilateral, and four, 27 per cent, unilateral, with an equal division between involvement of right and left sides in the latter. There was hilar infiltration in 20 per cent, and mediastinal enlargement in 7 per cent. Fluid was found in the pleural cavity in only one of these cases.

The remarkably rapid growth of pulmonary metastatic lesions was accurately demonstrated in the films of two patients whose primary lesion was in the testis. The first roentgenogram (Fig. 3) in the first case was taken five months after removal of the right testis for malignant tumor. There was a single nodular tumor at the right cardiophrenic angle. Two months later this had doubled in size and in another month (Fig. 4) the lesion was almost twice again as large; two months later the patient died. The second patient was a child three years of age in whose case a left testicular tumor was found six months before the first roentgenogram was taken. A large nodular metastatic growth was seen at the left cardiophrenic angle, posterior to the heart. Two months later there was a considerable increase in the size of the tumor, which in the course of another two months invaded the pleura. In the third film the extensive exudate filling the entire left side of the thorax, and displacing the heart to the right, was well demonstrated.

Only two cases of metastasis from carci-

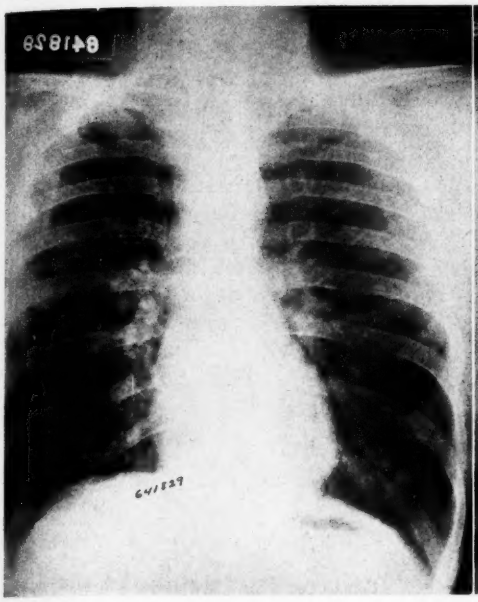


Fig. 7. Infiltration of hilum and mediastinum. Generalized, small, nodular, parenchymal lesions secondary to carcinoma of colon.

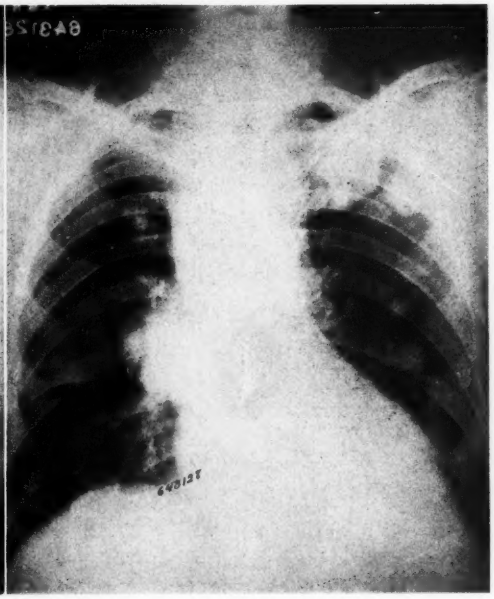


Fig. 8. Hilar, mediastinal, and parenchymal involvement secondary to renal tumor.

noma of the prostate gland were included, since practically all of the cases in which the two lesions were co-existent were never subjected to surgical exploration and as a consequence histologic verification was not obtained. In both of these cases there was bilateral involvement, and the lesions were fairly circumscribed. There were two cases of metastasis from carcinoma of the urinary bladder, with an equal division between unilateral and bilateral involvement. There was one case of carcinoma involving the scrotum, and in this case there were definitely circumscribed lesions on both sides.

Of the malignant lesions of the female generative tract, it was found that epithelioma of the cervix most frequently produced metastatic lesions in the lungs. This is probably explained by its greater incidence as a primary tumor. Among 13 cases, there was bilateral pulmonary involvement in 69 per cent. When the lesions were unilateral the left lung was more commonly affected. All of the lesions were definitely circumscribed, and there was little tendency to demonstrable enlargement of the lymph nodes. Pulmonary lesions were found in only one case of carcinoma of the body of the uterus; in this case there was unilateral, circumscribed involvement. In two cases of sarcoma of the body of the uterus the involvement was bilateral and well circumscribed. The five cases in which there were pulmonary lesions secondary to cystadenoma of the ovary were interesting in that only one exhibited parenchymal involvement; this was in the left lung. In the remaining four (80 per cent), there was a pleuritic exudate, with a fairly even division between involvement of either or both sides. In these instances involvement of the pulmonary parenchyma could not be demonstrated.

Figures 5 and 6 demonstrate the circumscribed nodular pulmonary lesions found secondary to epithelioma of the cervix of the uterus. In Figure 5 are seen many rela-

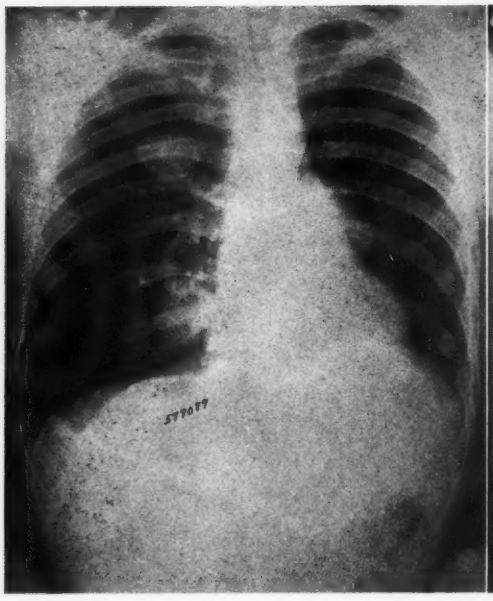


Fig. 9. Parenchymal involvement secondary to fibromyxochondrosarcoma.

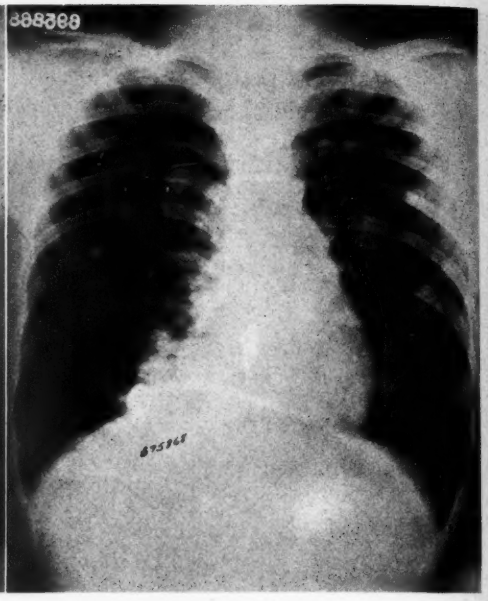


Fig. 10. Parenchymal involvement secondary to osteogenic sarcoma.

tively small nodules and one large nodule. The smaller nodules tend to increase rapidly in size, and a picture similar to that seen in Figure 6 is often found. In this illustration there are a few small nodules, overshadowed by the larger nodules distributed throughout both lungs. Although the extreme apex was rarely involved, the upper lobes were often found to contain metastatic newgrowths.

In the experience of this study, pulmonary lesions secondary to carcinoma of the stomach were extremely infrequent, and only three definite instances could be found. There was one case each of involvement of the right lung, the left lung, and both lungs. In two of these the lesions were circumscribed; the other lesion was of the infiltrative type. Carcinoma of the large bowel, however, would seem to have a greater tendency to produce metastatic lesions in the lungs. In these cases there was almost an equal division between unilateral and bilateral lesions, and, when unilateral, the lesions were usually found in the right side of the thorax. Enlargement of the mediastinal and hilar nodes was demonstrated in only one instance.

Figure 7 is from the case in which infiltration of the hilum and mediastinum was found. The generalized, rather small, nodular parenchymal lesions can be seen with some difficulty.

Only 11 cases of metastasis from carcinoma of the kidney were included, because in most of these there was no definite histologic proof of the primary lesion, although the diagnosis was definitely established clinically. All of the patients had bilateral parenchymal involvement; in two there was mediastinal, and in two, hilar enlargement. In nine (82 per cent) the lesions were dense and definitely circumscribed.

Involvement of the hilar and mediastinal nodes, as well as of the pulmonary parenchyma, is seen in Figure 8. The parenchy-

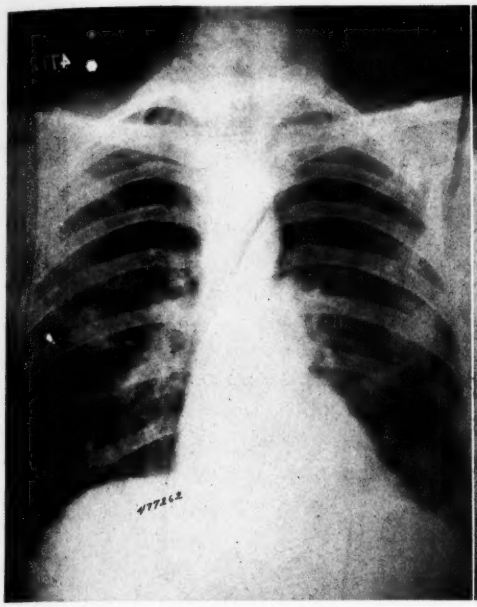


Fig. 11. Parenchymal involvement secondary to endothelioma of bone.

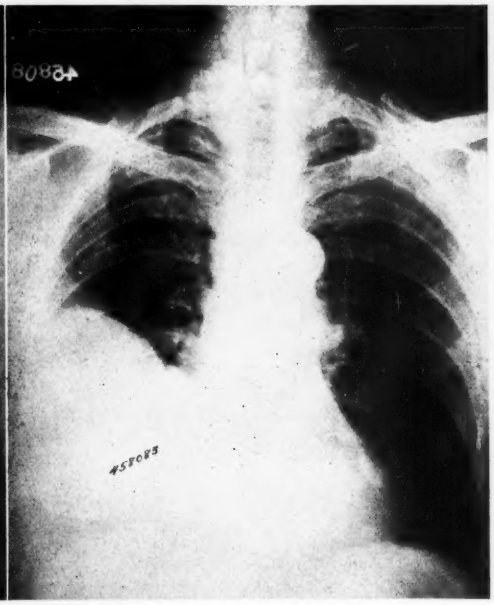


Fig. 12. Parenchymal involvement at right base secondary to melano-epithelioma.

mal lesions were usually dense and definitely circumscribed, and the upper lobes were not immune, as this demonstrates.

The number of patients with lesions secondary to tumors of bone was also small. Of four cases of chondrosarcoma, involvement was bilateral in three, and unilateral in one. In two cases of sarcoma, involvement was bilateral, and in one case, unilateral. Of two cases of pulmonary involvement secondary to endothelioma of bone, one was bilateral and one unilateral.

That there was great similarity between the parenchymal pulmonary lesions secondary to chondrosarcoma of bone and osteogenic sarcoma is well demonstrated in the following illustrations. In each figure are represented many fairly dense circumscribed lesions in both lungs. In a case of fibromyxochondrosarcoma (Fig. 9), there was a preference for the inner third of the lung, with hilar nodules as well. In a case of osteogenic sarcoma (Fig. 10), the distribution was more uniform. As Figure 11 demonstrates, the lesions secondary to endothelioma of bone, although they cast a fairly dense shadow, were not so definitely circumscribed; there was some haziness of the borders, indicating their invasive character. In this picture is demonstrated partial collapse of the lower lobes, with no free fluid in the pleural cavity. The mechanism of this process is difficult to understand; it is a rather common accompaniment of pulmonary metastasis.

More instances were found of pulmonary lesions metastatic from malignant conditions of the skin than were expected. Among 13 cases of melano-epithelioma, in eight (62 per cent), there was bilateral involvement; in three (23 per cent), unilateral parenchymal involvement, and in two, only mediastinal enlargement was demonstrable. The unilateral parenchymal lesions were on the right side, and the mediastinal thickening also was limited to the right side. Hilar enlargement

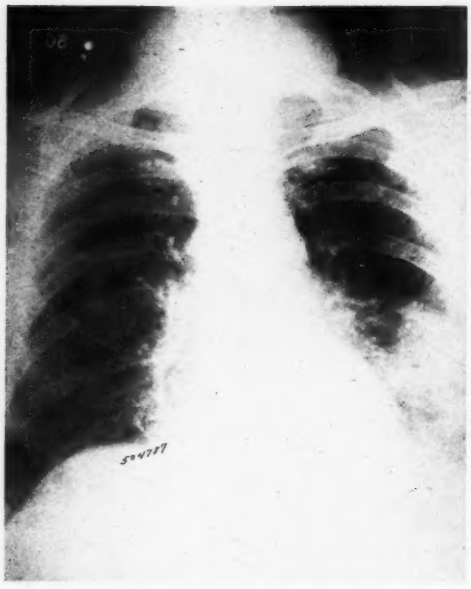


Fig. 13. Diffuse infiltration secondary to squamous-cell epithelioma of the skin.

was demonstrated in only one case. The parenchymal lesions were large and well circumscribed in 85 per cent of cases.

The large, dense, circumscribed type of parenchymal lesion usually found secondary to melano-epithelioma is well demonstrated in Figure 12. Here there is involvement only at the base on the right side. In most instances there were bilateral lesions in the presence of this condition, but when the lesions were unilateral, the base was involved in a manner similar to that herewith demonstrated.

Of eight cases of squamous-cell epithelioma, in six (75 per cent) there was bilateral, and in one, unilateral, parenchymal involvement. In two of these cases there was pleuritic exudate; in two, mediastinal enlargement, in one of which there was no parenchymal involvement. Only half of the lesions in this group were well circumscribed.

The diffuse infiltrating type of lesion often found secondary to squamous-cell epithelioma of the skin is clearly demonstrated in Figure 13. Although there are several fairly well circumscribed nodules, the predominant lesion is infiltrative, and this extends to the hilar structures as well as through the parenchyma.

Parenchymal pulmonary involvement was found in eight cases of fibrosarcoma of the soft tissues. In six (75 per cent) this was bilateral; in the remaining two, unilateral. The lesions were all definitely circumscribed, and in two cases were accompanied by pleuritic exudate. Nodular parenchymal tumors of varying size, but often attaining a large diameter, were usually found. The rapid progression from multiple, relatively small, ill-defined lesions, to the large nodules so often seen is well illustrated in Figures 14 and 15, taken two months apart. At the time the second roentgenogram (Fig. 15) was made, spontaneous pneumothorax had developed on the right side, but collapse of the middle lobe was not complete, probably due to the large nodular lesion which developed in it.

Eight cases of carcinoma of the thyroid gland were found to have produced metastatic lesions; in four (50 per cent) there was enlargement of the mediastinum, and in four, enlargement of the hilum. Parenchymal lesions were found in seven cases, four of which were unilateral. In one case there was a pleuritic exudate. When bilateral, the lesions usually were of the infiltrative type, but when unilateral they were usually circumscribed.

The lesions seen most typically with carcinoma of the thyroid gland are shown in Figure 16. There is infiltration throughout both pulmonary fields, in the mediastinum, and in both hilar regions. In addition, a few indefinite nodules are seen.

In the absence of a relevant history the roentgenologist is often quite as unable to make a positive diagnosis of metastasis as is an internist who has not the benefit of

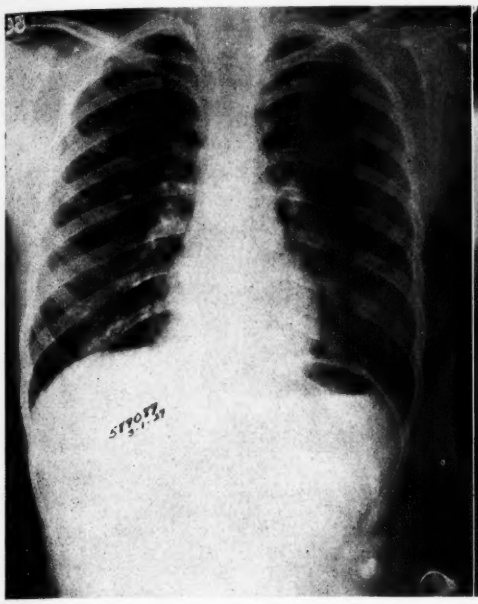


Fig. 14. Parenchymal tumors secondary to fibrosarcoma of soft tissues.

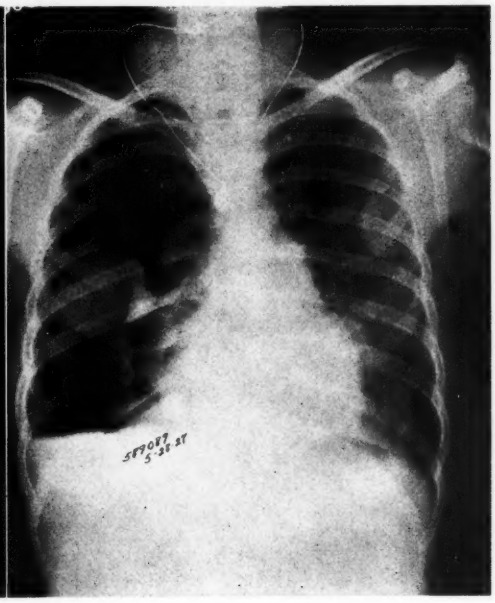


Fig. 15. Same case as Figure 14, two months later.

roentgenologic examination. This is particularly true in cases in which there are single, large, nodular tumors, which could easily be confused with isolated pleural plaques, calcified lymph nodes, infarcts, primary bronchial neoplasms, or benign tumors such as dermoids, echinococcus cysts, fibromas or neurofibromas, localized bronchiectatic abscesses, or acinous, nodosal types of tuberculosis. Pleural plaques could be ruled out by study of stereoscopic films, and neurofibromas by fluoroscopy, since the latter tumors arise from the vicinity of the spinal column. The comparative rarity of benign tumors makes it safe to ignore them in a differential consideration, in most instances. Calcified lymph nodes usually have a more densely granular, less homogeneous appearance than metastatic foci. Localized pneumonitis, bronchiectatic abscess, or early primary bronchiogenic malignant growths are often indistinguishable from the condition under consideration. Diagnosis of nodosal tuberculosis cannot be made in the absence of sputum positive for *Mycobacterium tuberculosis*. Infarction also would offer difficulty, but the history of the patient would be of great assistance here.

Multiple, large, nodular lesions are much more simple of diagnosis. The condition of the patient should rule out bronchopneumonia, bronchiectasis, or hematogenous abscesses. In all of these conditions the isolated nodules are much less sharply circumscribed. The distribution of bronchiectatic lesions is usually characteristic; bronchopneumonic nodules are surrounded by a considerable parenchymal reaction, with a fuzzy increase in density. In many of the nodules in cases of hematogenous abscess definite fluid levels will be seen, whereas secondary degeneration with liquefaction is seldom seen in multiple nodular metastatic lesions.

Miliary nodular or miliary infiltrative lesions must be distinguished from lymphoblastoma, pneumonoconiosis, actinomycosis,

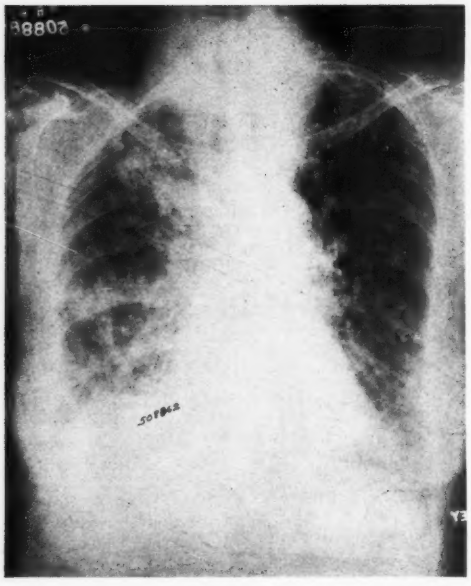


Fig. 16. Pulmonary lesions secondary to carcinoma of the thyroid gland.

and miliary tuberculosis. Any of these conditions may be accompanied by hilar or mediastinal thickening; therefore, the diagnosis depends largely on the history and the physical condition of the patient. Certainly there are too many exceptions to the old rule that pneumonoconiosis is typically found in the middle third of the lung, and that the nodules in metastatic malignancy grow larger and more thickly distributed from the apex downward.

Benign and malignant, primary and secondary tumors of the ribs are often accompanied by a pleural reaction such as might be found in metastatic malignant growths. Empyema and old pleural thickening must also be ruled out. In the majority of instances of metastatic pleural involvement there are parenchymal evidences of the disease as well, which greatly simplify the diagnosis.

In the presence of hilar and mediastinal enlargement, one must exclude lymphoblastomas. In these would be found the characteristically enlarged lymph nodes in other parts of the body, or a blood picture which should serve to establish the diagnosis. Inflammatory nodular enlargement should be eliminated by the absence of any parenchymal inflammatory lesion. In substernal goiter one should find an enlarged superficial thyroid gland, and tracheal tug. Aneurysm or diffuse widening of the arch of the aorta is readily proved by fluoroscopic observation.

SUMMARY

In carcinoma of the breast there was no parenchymal involvement in one-eighth (12 per cent) of the cases. When parenchymal involvement was present, it was usually bilateral; if unilateral, the right side was involved slightly more frequently than the left. In more than a third (35 per cent) of the cases, there was an accompanying pleuritic exudate. Increased hilar infiltration was found in 39 per cent. The frequency of infiltrative lesions was almost as great as that of discrete nodules. The distinctive feature was pleural involvement.

Malignant testicular tumors produced definitely circumscribed pulmonary metastasis, usually bilateral, and accompanied by hilar infiltration in 20 per cent of cases. No pleural lesions were demonstrable. Carcinoma of the prostate gland produced bilateral, fairly well circumscribed pulmonary lesions, and carcinoma of the bladder gave rise to either unilateral or bilateral metastasis.

Epithelioma of the uterine cervix also produced well circumscribed metastatic lesions, but although there was a greater likelihood of bilateral involvement, lesions were often found only on one side. The pulmonary lesions secondary to cystadenoma of the ovary resembled peritoneal extension, in that a pleuritic exudate was produced in all cases.

Carcinoma of the large bowel produced pulmonary metastasis with relative fre-

quency, carcinoma of the stomach, rarely. In either case there was as great a likelihood of unilateral as of bilateral involvement.

The pulmonary metastasis of carcinoma of the kidney was usually bilateral, well circumscribed, and might be accompanied by hilar or mediastinal thickening.

There was nothing distinctive about the pulmonary lesions secondary to tumors of bone.

Melano-epithelioma and squamous-cell epithelioma give rise to metastasis more frequently than is sometimes believed. In each instance there was predominance of bilateral involvement. In melano-epithelioma there was a greater tendency to definitely circumscribed lesions; in squamous-cell epithelioma, to infiltrative lesions.

Carcinoma of the thyroid gland, like carcinoma of the breast, seemed often to form its metastatic lesions by direct extension, with the production of mediastinal and hilar thickening. This is, however, accompanied by definite parenchymal lesions as well.

BIBLIOGRAPHY

1. ADLER: Quoted by Blankenhorn, M. A.
2. ARNSPERGER, HANS: Die Röntgenuntersuchung der Brustorgane und ihre Ergebnisse für Physiologie und Pathologie. F. C. W. Vogel, Leipzig, 1909, pp. 152-155.
3. ASSMANN, H.: Erfahrungen über die Röntgenuntersuchung der Lungen. G. Fischer, Jena, 1914, pp. 96-101.
4. ATKINSON, C. E.: Pulmonary Neoplasms. Am. Rev. Tuberc., November, 1926, XIV, 556-566.
5. BARD, L.: Du diagnostic de la lymphangite pulmonaire cancéreuse généralisée. Rev. méd. de la Suisse, January, 1918, XXXVIII, 5-14.
6. BARJON, F.: Radio-diagnosis of Pleuro-pulmonary Affections. Yale University Press, New Haven, 1918, pp. 142-153.
7. BECK, E. G.: Case Report of Sarcoma Metastasis in the Lung Seventeen Years after Primary Growth. Arch. Surg., January, 1925, X, 469-474.
8. BELOT, J., NEBOUT, and DERUAS: Un cas de metastase pulmonaire: sarcome. Bull. et mém. Soc. radiol. méd. de France, February, 1929, XVII, 73.
9. BERNARD, LÉON, and CAIN, ANDRÉ: La lymphangite cancéreuse généralisée du poumon. Arch. de méd. expér. et d'anat. path., 1913, XXV, 333-354.
10. BLANKENHORN, M. A.: Newgrowths of the Lung. Nelson's Loose-leaf Medicine, 1920, III, 523-528.
11. BLUM, ROBERT: Drei seltene Befunde zu Röntgendiagnostik der Thoraxtumoren. Fortschr. a. d. Geb. d. Röntgenstrahlen, 1928, XXXVII, 145-155.
12. BRISTOWE: Quoted by Moore, A. B., and Carman, R. D.
13. BRYAN, LLOYD: Secondary Hypertrophic Osteoarthropathy with Metastatic Sarcoma of Lung. Am. Jour. Roentgenol., June, 1920, VII, 286-291.
14. BURT, S. S.: Multiple Metastatic Sarcomata of the Lungs. Philadelphia Med. Jour., Sept. 22, 1900, VI, 545-550.
15. CHAOUL, H.: Klinische Röntgendiagnostik der Erkrankungen der Brustorgane. Julius Springer, Berlin, 1929, pp. 92-97.
16. CRANE, A. W.: Pulmonary Metastasis. Am. Jour. Roentgenol., October, 1918, V, 479-482.
17. DEIST, HELLMUTH: Zur Differentialdiagnose: Lungentumor und chronische Pneumonie. Klin. Wchnschr., March 19, 1923, II, 550-552.
18. Idem: Diagnose der Lungentumoren. Klin. Wchnschr., Nov. 25, 1924, III, 2200-2206.
19. DIETLEN, HANS: Die Bedeutung der Röntgenuntersuchung der Lungen und des Mediastinums für die innere Medizin. Verhandl. d. deutsch. Gesellsch. f. innere Med., 1927, XXXIX, 402-422.
20. EDLING, LARS: Ein sehr seltener Fall gutartigen Lungentumors. Fortschr. a. d. Geb. d. Röntgenstrahlen, 1917, XXV, 25-28.
21. EISLER, FRITZ: Zur Röntgendiagnose der Lungentumoren. Wien. Arch. f. inn. Med., 1925, XI, 245-250.
22. EVANS, W. A., and LEUCUTIA, T.: Deep Roentgen Therapy of Neoplastic Pulmonary Metastasis. Am. Jour. Roentgenol. and Rad. Ther., January, 1924, XI, 35-50.
23. FARRELL, J. T.: The Roentgen Diagnosis of Intrathoracic Neoplasms. RADIOLOGY, July, 1929, XIII, 1-16.
24. HAMMAN, LOUIS: Tumors of the Lung. Oxford Medicine, 1920, II, 81-83.
25. HILLAIRET: Observations d'angioleucite pulmonaire dans le cancer de l'estomac. Bull. et mém. Soc. med. d. hôp. de Par., 1874, XI, 78-87.
26. HIRSCH, I. S.: The Roentgen Diagnosis of Malignant Neoplasms of the Lung. RADIOLOGY, December, 1927, IX, 470-496.
27. HOLT, O. P., and RATTERMAN, HELENA T.: Multiple Metastatic Sarcomas of the Lungs. Jour. Am. Med. Assn., Jan. 15, 1916, LXVI, 171, 172.
28. HOYT, D. M.: A Case of Secondary Carcinoma of the Lung, with Some Observations on the Diagnosis. Arch. Diagnosis, 1912, V, 56-62.
29. HUNT, T. C.: Pulmonary Neoplasms: A Report of Twenty-six Cases. Lancet, April 13, 1929, I, 759-762.
30. JACKSON, HARRY: Multiple Metastatic Sarcomas of the Lungs. Jour. Am. Med. Assn., March 11, 1916, LXVI, 833.
31. JERMAIN, L. F.: Tumors of the Lung. Tice's Practice of Medicine, 1923, V, 565-576.
32. KARRENSTEIN: Quoted by Blankenhorn, M. A.
33. KERLEY, PETER: Neoplasms of the Lungs and Bronchi. British Jour. Radiol., September, 1925, XXX, 333-349.
34. KIENBÖCK, ROBERT: Zur Frühdiagnose der intrapulmonalen Tumormetastasen. Med. Klin., Sept. 10, 1926, XXII, 1400-1403.
35. LENK, ROBERT: Die Differentialdiagnose zwis-

chen Tumor und Tuberkulose der Lunge. Klin. Wchnschr., April 30, 1926, V, 801-805.
36. Idem: Zur Differentialdiagnose der miliaren Tumorose und Tuberculose im Röntgenbilde. Klin. Wchnschr., July 22, 1928, VII, 1414, 1415.
37. Leo, H.: Nachweis eines Osteosarkoms der Lungen durch Röntgenstrahlen. Berl. klin. Wchnschr., April 18, 1898, XVI, 349, 350.
38. Lestocquoy, C.: Contribution a l'étude histopathologique de la neurogliomatose. Maladie de Recklinghausen a propos d'un cas de tumeurs pleuro-pulmonaires. Ann. de méd., 1925, XVIII, 55-71.
39. LeWald, L. T.: Newgrowths of the Lung, Primary and Secondary; Their Classifications, Characteristics, and Differential Diagnosis. Radiology, March, 1925, IV, 212-220.
40. Martin, T. M.: Metastatic Sarcoma of the Lung Simulating Pneumonia. British Med. Jour., Oct. 11, 1913, II, 939, 940.
41. Idem: Metastasis of Lung Secondary to Sarcoma Uteri Simulating Pneumonia. Clin. Jour., Oct. 1, 1913, XLII, 416.
42. Moore, A. B., and Carman, R. D.: Radiographic Diagnosis of Metastatic Pulmonary Malignancy. Am. Jour. Roentgenol., March, 1916, III, 126-131.
43. Oliver, Paul: Metastatic Sarcoma of Lung with Hypertrophic Pulmonary Osteo-arthropathy. Surg. Clin. Chicago, 1918, II, 361-368.
44. Otten, M.: Die Röntgendiagnose der Lungenschwülste. Fortschr. a. d. Geb. d. Röntgenstrahlen, 1910, XV, 1-31.
45. Packard, E. N.: Massive Collapse (Atelectasis) Associated with Pulmonary Tuberculosis and Tumor. Am. Rev. Tuberc., July, 1928, XVIII, 7-25.
46. Robey, W. H.: Malignant Disease of the Lungs. Med. Clin. No. Am., 1921, IV, 1811-1837.
47. Sante, L. R.: The Chest Roentgenologically Considered. P. B. Hoeber, Inc., New York, 1930, p. 409.
48. Schwab, Ernst: Ein Fall von malignen Myommetastasen in der Lunge. Fortschr. a. d. Geb. d. Röntgenstrahlen, 1925, XXXIII, 733, 734.
49. Scott, J. T.: Report on a Case of Secondary Carcinoma of the Lung, with Pulmonary Tuberculosis. Virginia Med. Month., April, 1923, L, 39-41.
50. Shennan, T.: Tumors of Mediastinum and Lung. Jour. Path. and Bacteriol., 1928, XXXI, 365-402.
51. Sonnenfeld, Arthur: Die klinische und röntgenlogische Diagnose und Differentialdiagnose der bösartigen Lungengeschwülste. Med. Klin., April 20, 1928, XXIV, 617-619; April 27, 1928, XXIV, 659-662.
52. Warfield, L. M.: Secondary Carcinoma of the Lung. Med. Rec., July 24, 1909, LXXVI, 145-148.
53. Weil, Alfred: Die Miliarkarzinose der Lunge im Röntgenbilde. Fortschr. a. d. Geb. d. Röntgenstrahlen, 1918, XXV, 420, 421.

COMPARISON OF VARIOUS SOURCES OF INTERSTITIAL RADIATION[1]

By EDITH H. QUIMBY, M.A., and FRED W. STEWART, M.D.
Memorial Hospital, New York

THE importance of interstitial radiation in cancer therapy is constantly being emphasized. It is now recognized that it is impossible to deal adequately with some types of lesion by external irradiation alone, but that many of these can be controlled by the judicious use of radium or radon needles, or radon seeds. Up to the present time the dosage for these buried sources has been largely developed empirically by each radiologist for himself, except in the case of the gold radon seeds. For these, on a basis of experimental data, a practical system of dosage has been developed which is very satisfactory for lesions up to several centimeters in diameter (1, 2).

For various types of implants there has been so far very little basis for comparison. Dosages employed in one clinic could not be related to those in others using somewhat different types of sources. It has thus been difficult to duplicate treatments in different clinics, unless the implants employed happened to be the same size and strength.

Some time ago a preliminary paper was published correlating the effects of weak (1-4 mc.) radon seeds, permanent or removable, and certain 1 mg. radium needles, in bleaching butter (3). This work has now been extended to certain 5 and 10 mg. needles and seeds up to 11 mc., of various lengths. In addition to the use of the butter medium, the production of tissue necrosis in the dorsal muscles of rabbits has been employed. The purpose of the present paper is to present the results of these experiments and some conclusions drawn from them.

There is considerable variation among the types of implant in use. Most of the filtered permanent radon implants (gold seeds) have a filter of from 0.25 to 0.35 mm. gold, and a length of 4 or 5 millimeters. The removable radon implants have a filter of from 0.25 to 0.3 mm. platinum, and are 5 or 6 mm. long. The strengths of either of these may range from a fraction of a millicurie to four or five millicuries—seldom more. Such small differences in filtration and length may easily be corrected for, or neglected for a first approximation. On the other hand, the needles may have filtrations varying from 0.25 mm. steel or monel metal to 0.5 mm. or more of platinum, and may range in length from a few millimeters to several centimeters. Obviously this part of the problem is much more difficult. It is impracticable to cover the whole range experimentally, but a good deal of information can be obtained from a detailed study of relations between a few types of implants.

The sources of radiation used in the present study were gold seeds and platinum radium needles. Detailed specifications are given in Table I.

TABLE I.—TYPES OF IMPLANT USED

Type	Filter	Diameter	Length (active portion)	Strength
Seed	0.3 mm. Au	0.75 mm.	4 mm.	1-11 mc.
Needle	0.25 mm. Pt	0.75 mm.	7 mm.	1 mg.
Needle	0.25 mm. Pt	1.0 mm.	10 mm.	5 mg.
Needle	0.25 mm. Pt	1.1 mm.	16 mm.	10 mg.

The two reactions used, as already stated, were the bleaching of butter and the formation of tissue necrosis. The bleaching of butter has been used in a great deal of work

[1]Presented before the Third International Congress on Radiology, Paris, July, 1931.

regarding dosage from both gold and glass seeds, and its use has been discussed in previous papers (4, 5). The effect has been shown to be proportional, under proper conditions, to the production of tissue necrosis or to the formation of a skin erythema.

However, in this particular problem, with the introduction of doses from needles as well as seeds, it seems important to extend the correlation. For this reason several series of experiments were made on the production of tissue necrosis in rabbits, for different times and intensities of irradiation.

In these experiments with rabbits the hair of the back was clipped (not shaved), the parts plentifully swabbed with iodine and alcohol, and the seeds or needles inserted under ether anesthesia. With comparatively weak seeds or 1-mg. needles, three were inserted in each dorsal muscle. With stronger seeds or the 5-mg. needles, only two were used in each side. The 10-mg. needles were not used in rabbits. The seeds were introduced with a regular gold seed trocar, and no precautions were necessary to keep them in place. The needles, since they were to be withdrawn at intervals before the death of the animal, had to have a wire attached, and precautions were necessary to keep the animals from scratching them out. A special curved inserter was used, which was introduced into the muscle as shown in Figure 1-*A*. The needle was threaded with noncorrosive wire, one end of which was pushed back through the trocar, and by means of this the needle was drawn partly into the opening. The trocar and needle were then pulled back until the needle was in the desired position, when the wire was released and the trocar slipped out. The two ends of the wire were firmly twisted together as in Figure 1-*B*, and the needle remained in place during the course of the experiment. The needles were removed at various times after insertion by snipping the wire and drawing gently on the eye end. The animals were killed at definite times after the withdrawal of the needles and the necrotic areas determined as follows: The dorsal muscles were dissected out immediately, and the region of radiation effect could be localized by palpation or transillumination. Each was sectioned at its center, perpendicular to the track of the needle, and the diameter of the necrotic area determined in the fresh tissue, by means of small calipers. In the case of the seeds, the animals were sacrificed one, two, or three weeks after the insertion, and the diameters of the affected areas found in the same manner.

Fig. 1. Method of inserting radium needle into rabbit muscle. *(A)* Curved trocar; *(B)* needle fastened in place.

The data thus obtained with rabbits were not so definite or exact as those obtained with butter. The lesion formed does not, on section, always have a sharp and distinct outline, it is apt to be somewhat irregular in shape and to vary in appearance from one animal to another. Sometimes it is a sharply demarcated, circular white area, surrounded by a zone a millimeter or so wide, of intensely hemorrhagic tissue. This is the ideal case. However, the lesion may not show a circular section, even when great pains are taken

TABLE II.—DIAMETER OF NECROTIC REGION IN RABBIT EXPERIMENTS, WITH GOLD SEEDS

(A) Authors' data

No. of exp.	Initial millicuries	Days	Millicurie-hours	Diameter (cm.)
4	1.1	10	122	2.2
6	0.92	15	114	2.2
Av.			**118**	**2.2**
19	2.10	7	**200**	**2.5**
3	1.92	14	232	3.75
4	2.08	10	230	3.5
11	2.60	7	248	2.5
Av.			**237**	**3.25**
18	2.10	14	256	3.5
5	2.14	15	266	4.0
11	2.83	7	270	3.0
9	2.16	21	280	3.6
Av.			**269**	**3.6**
17	2.30	21	300	3.6
10	2.53	14	309	3.0
11	3.26	7	310	4.0
11	3.28	7	312	3.8
19	3.40	7	324	3.8
Av.			**311**	**3.5**
14	2.84	14	345	4.5
4	3.25	10	360	4.6
10	2.97	14	362	4.5
10	3.12	14	380	4.0
19	4.00	7	381	5.0
12	3.00	21	390	3.8
Av.			**370**	**4.4**
5	3.59	15	445	5.25
18	3.70	14	452	4.5
Av.			**448**	**4.8**
17	3.80	21	494	5.0
10	4.08	14	498	4.2
12	3.96	21	514	5.0
19	5.40	7	515	5.7
18	4.30	14	525	5.8
Av.			**509**	**5.1**
4	5.46	10	**605**	**5.7**
4	6.16	10	685	6.5
6	5.68	14	692	6.0
5	5.67	15	702	6.2
18	5.80	14	708	7.0
19	7.60	7	723	7.0
Av.			**702**	**6.5**
5	6.33	15	786	6.5
18	6.70	14	817	8.0
12	6.38	21	828	6.0
17	6.40	21	831	7.5
14	6.90	14	842	6.5
Av.			**821**	**6.9**
17	6.90	21	895	7.8
6	7.50	14	915	7.2
Av.			**905**	**7.5**
13	7.71	21	**1000**	**7.5**

(B) Cutler's Data

	0.59	14	**72**	**2.50**
	0.91	14	112	3.00
	0.99	14	122	3.80
Av.			**117**	**3.40**
	2.02	14	248	4.50
	2.63	7	250	4.17
	2.09	14	257	3.90
	2.10	14	258	3.80
	2.11	14	259	3.80
Av.			**254**	**4.03**
	2.20	14	270	4.30
	3.01	7	286	4.92
Av.			**278**	**4.61**
	3.11	14	382	4.90
	4.38	7	416	5.66
Av.			**398**	**5.28**
	4.69	7	444	6.70
	5.01	7	475	6.27
	3.89	14	478	5.00
	3.92	14	481	4.50
Av.			**470**	**5.62**
	5.60	7	**531**	**6.37**
	5.10	14	626	5.90
	5.12	14	630	5.80
Av.			**628**	**5.85**
	7.02	7	665	7.67
	7.22	7	685	7.75
Av.			**675**	**7.71**
	7.99	7	757	6.80
	8.08	7	766	6.50
Av.			**761**	**6.65**
	11.03	7	1045	8.85
	11.90	7	1130	9.27
Av.			**1088**	**9.06**

to insure a cut perpendicular to the implant. The two zones may partly merge, so that the outline of the necrotic area is not sharply defined. The hemorrhagic area may be partly or completely missing. Also, there is considerable variation in the size of the affected area in different individuals, for seeds of the same strength. From these considerations, it is evident that no valid conclusions can be drawn from a small number of experiments of this type. It is necessary to perform a large number of experiments and treat the results statistically.

Of the 68 seeds implanted in 14 rabbits, 42 were recovered when the animals were sacrificed. The others had probably been

TABLE III.—DIAMETERS OF NECROTIC REGIONS IN RABBIT EXPERIMENTS WITH 5-MG. RADIUM NEEDLES

Days	Mg.-hr.	Diameter of necrotic area (mm.)			
		Rabbit A	Rabbit B	Rabbit C	Average
4	480	4.5	5.3	5.8	5.2
8	960	7.5	7.0	6.5	7.0
12	1440	7.5	8.5	8.0	8.0
16	1920	10.0	9.3	9.5	9.6

pushed in too deeply, and entered the pleural or abdominal cavities. The measurements of the necrotic zones around these seeds are collected in the first part of Table II. (These measurements all refer to the outer limit of the necrotic region, as being the most definite for observation.) There are also available for inclusion in this comparison, measurements made on 25 seeds by Dr. Cutler (6) in experiments performed in exactly the same manner. These are given in the second part of Table II.

Since these measurements were made before the seeds had completely decayed, it seems reasonable to relate the effect produced to the actual millicurie-hours used rather than to the initial strengths of the seeds. Some other investigators have found no conclusive evidence of increase in diameter of the affected area after the first few days, but in all these cases the experimental variations were so great that they might easily have masked a systematic small increase (7, 8). The same holds true for our data. Whether the observations are compared on a basis of initial strength of seeds, or of total millicurie-hours, there is considerable variation among values that should be the same. This is apparently unavoidable in this type of experiment, and it is, therefore, as just stated, necessary to use averages of several observations. Accordingly, the seeds which had delivered approximately equal doses have been grouped together and averages taken. These average values are indicated in heavy type in the tabulation.

In the case of the needles, four of the same size and strength were inserted into each animal used; the first was removed four days after the insertion, and the others at successive four-day intervals. The animals were sacrificed a week after the removal of the last needle. Of course, in such an experiment, the question arises of repair of lesions from the needles removed first. However, Cutler *(loc. cit.)* found that any repair which would tend to diminish the size of the area of necrosis probably is not well established before the fourth week, and none of these experiments extended over that period of time. Table III shows the variations in necrotic area with time for the 5-mg. needles in three successive experiments.

Tables II and III contain a summary of the principal rabbit data.

The method of carrying out the butter experiments is shown in Figure 2. This is a Petri dish full of ordinary salt table butter containing an assortment of gold seeds and needles. The butter is not subjected to any special preparation, merely packed tightly in the dish and smoothed off. The implants are inserted flush with the surface, and the whole is covered with a sheet of oiled paper and a block of beeswax a few centimeters thick. The purpose of the wax is to provide a scattering material so that the physical behavior of the radiations will be more nearly the same as when the implants are actually in tissue. The material is kept in the refrigerator except during the measurements. The diameters of the bleached areas are measured daily, with fine calipers, and at the end of each experiment curves are plotted showing the increase of area with time, for each tube, or the increase from tube to tube, for different times of exposure. Figure 3 shows a typical set of such curves. In *A*, each curve shows the increase in diameter

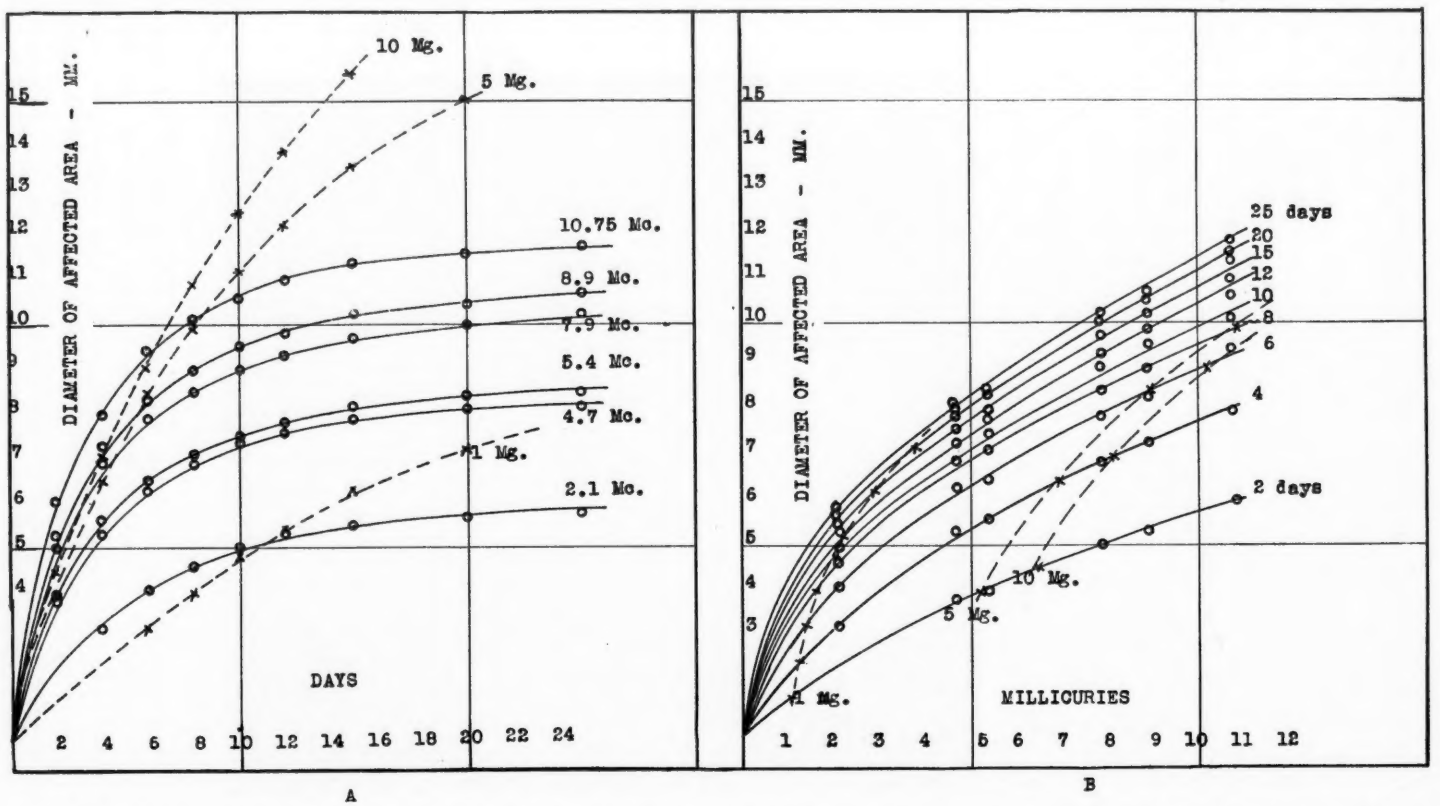


Fig. 3. Experimental butter data: *(A)* The variation in diameter of bleached area with time, for various strengths of seed; *(B)* The variation in diameter of bleached area with millicuries, for different times of exposure. The dotted lines represent the data for the needles. For an explanation of the manner of drawing them, see text.

with time, for an individual seed or needle, as indicated. In *B*, the solid curves show the variation in diameter with millicurie content of seeds, for specified days. The dotted curves refer to the needles, but, of course, in this case the horizontal co-ordinates do not apply. These curves for the needles are obtained by plotting the diameter for the needles for each day on the corresponding radon curve for that day. Figure 4 shows the same sets of curves plotted on a percentage basis, 100 per cent being arbitrarily taken as the diameter for the 5-mg. needle on the tenth day.

Every experiment was repeated at least three times. The actual sizes of the affected areas varied from one experiment to another (due, probably, to differences in the butter), sometimes by several per cent, but the *rate of increase* with either time or strength was quite constant.

Since it is desired to correlate these butter data with those for the rabbits, which have been expressed in terms of the variation of the affected area with millicurie-hour dose, it is necessary to reduce the butter curves also to this basis. This is done, for the set of Figure 4, in Figure 5. From this figure it is immediately evident that the increase in diameter with millicurie-hours varies somewhat with the initial strength of the implant, and that the weaker ones are relatively a

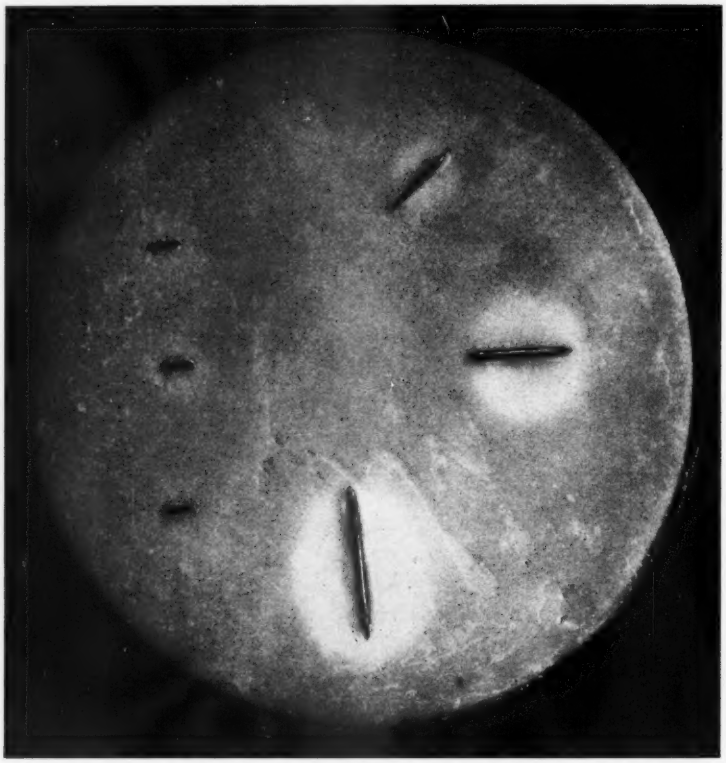


Fig. 2. Petri dish containing butter with 1-, 5-, and 10-mg. needles and 1-, 2-, and 3-mc. seeds. (The actual bleached areas are very much more sharply outlined than the photograph indicates. The yellow-and-white color contrast is difficult to show photographically.)

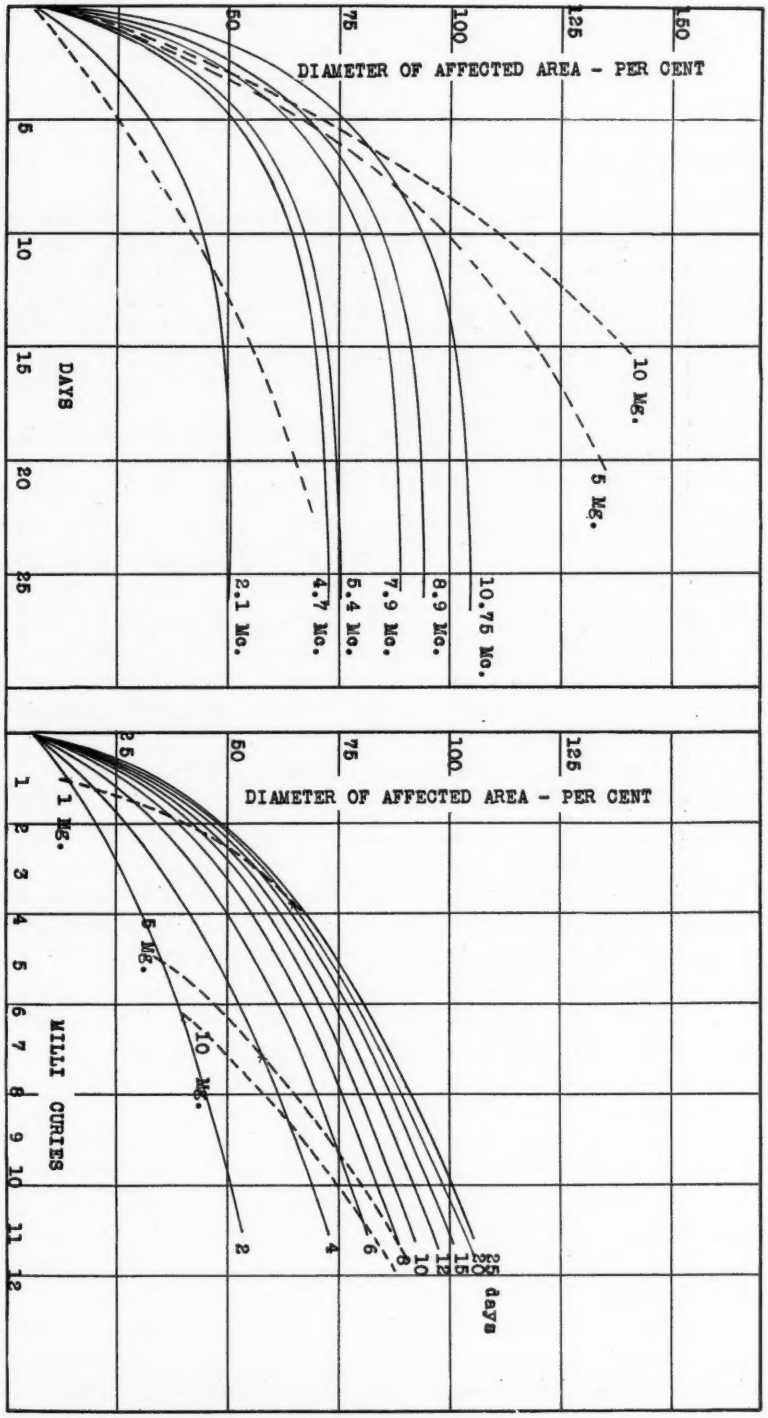


Fig. 4. Data of Figure 3, plotted to show change in area in per cent.

TABLE IV.—SUMMARY OF BUTTER EXPERIMENTS. INCREASE IN BLEACHED AREA WITH INCREASE IN MILLICURIE-HOUR DOSE

Mc.-hr.	Diameter of bleached area (per cent)					
	Expt. 1	Expt. 2	Expt. 3	Expt. 4	Expt. 5	Average
200	53	52	55	52		53
300	73	70	74	71	74	72
400	90	86	88	87	87	87
500	100	100	100	100	100	100
600	112	112	111	113	111	112
700	122		121	123	122	122
800			130	134	132	132
900			138	144	142	142
1000			146	150	151	149
1100			152	156	156	155
1200			159	160	162	160

little more efficient. (Of course, with the needles the factor of the difference in length must also be considered; this will be discussed later.) This phenomenon is always observed in butter experiments of this type, and would seem to indicate an increased sensitivity of the butter with age, due, perhaps, to some chemical change taking place. For this reason, effects produced in different time-intervals in the same butter are not strictly comparable. In order to obtain a single curve which might be considered to express the facts, an average curve has been used, such as the one shown in the heavy line. The rate of increase shown by this curve is approximately that for the seeds except for the last few days of life of the very weak ones, in which abnormally large effects are observed. In fact, excluding the last few readings on the weakest seed, the greatest variation between the average curve and the experimental points is less than 7 per cent. Similar data have been compiled for five sets of butter experiments, and the rates of increase of diameter on the average curves, with increase in millicurie-hours, for all of them are given in Table IV. The average values from this tabulation afford a basis for comparison with the rabbit values of Table II. Such a comparison is made in Figure 6. The curve is drawn through the average values of Table IV. The circles and crosses represent values from our data and Cutler's, respectively, assuming the effect at 500 mc.-hr. to be 100 per cent. The agreement is excellent.

TABLE IV-A.—EXTENSIONS OF TABLE IV, FOR OTHER SOURCES OF RADIATION

5-mg. needle		10-mg. needle		50-mg. tube	
Mg.-hr.	Per cent	Mg.-hr.	Per cent	Mg.-hr.	Per cent
240	46	960	65	24,000	36
480	75	1,440	84	3,600	47
720	100	1,920	100	4,800	57
960	117	2,400	115	6,000	66
1,200	131	2,880	126	8,400	80
1,800	161	3,360	140	12,000	100
				14,400	112
				16,800	123
				19,600	140
				24,000	156

In the case of the needles this reduction to a milligram-hour basis is not necessary, since we have already the common basis of variation of area with time in a single experiment. Comparison may be made of the values for the rabbits given in Table III and for the butter in the 5-mg. needle curves of Figures 3 or 4. This is done in Figure 7. The points represent the rabbit data, each one representing a single experiment in this case rather than an average; the line is plotted from values obtained from the curve, on the assumption that the diameter for the tenth day is 8 millimeters. The agreement is not so close as in the case of the seeds, but the data are much more scanty.

From the results of these two comparisons it seems justifiable to use the information obtained from butter experiments as a first approximation to calculations of interstitial

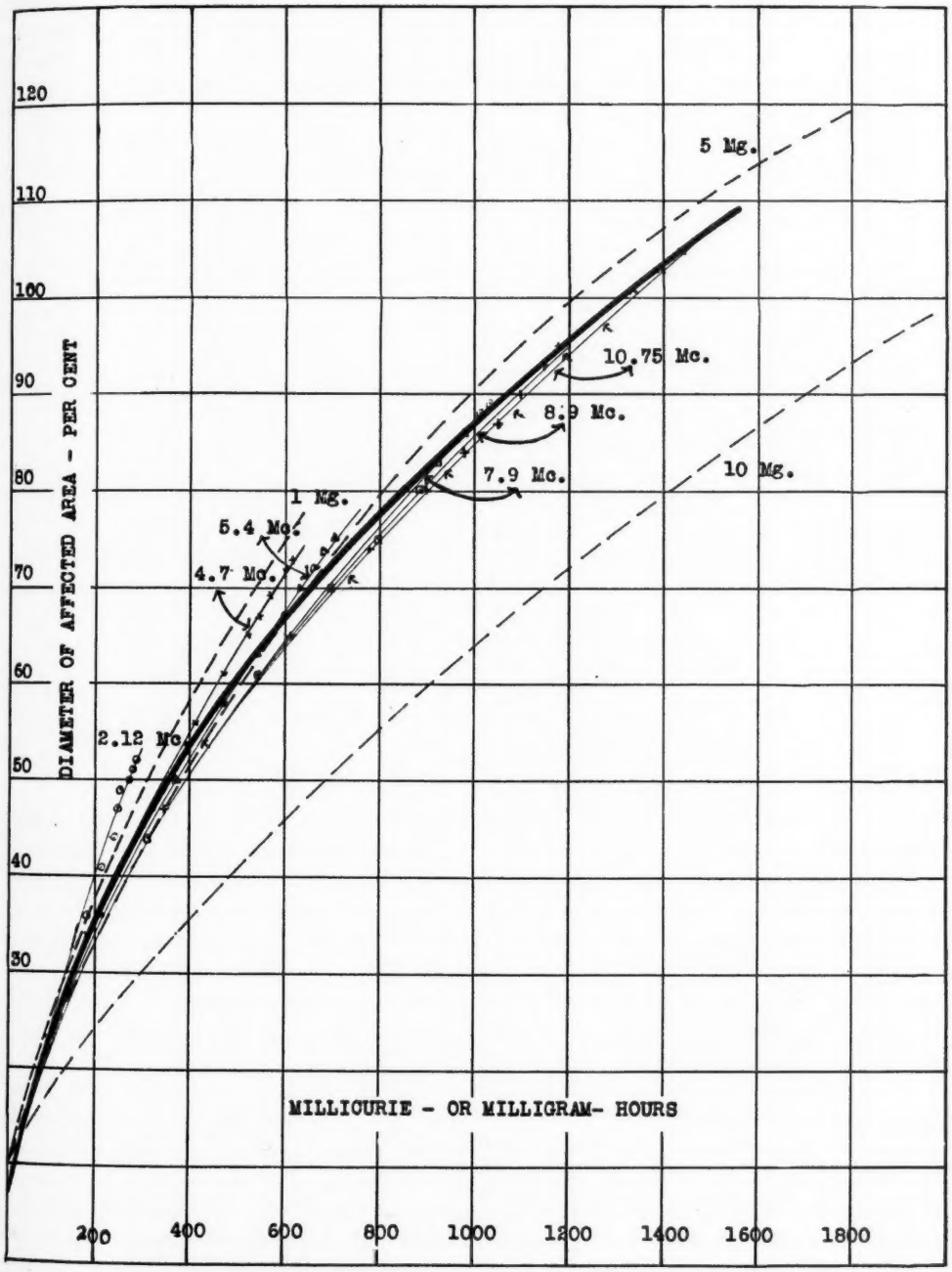


Fig. 5. Variation in diameter of bleached area in butter with millicurie- or milligram-hour dose, for different implants.

tissue dosage. The question of the repair processes in living tissue, which is frequently cited as an objection to apply to tissue dosage any information obtained from lifeless media, apparently need not be considered, since good agreement is obtained without taking it into account.

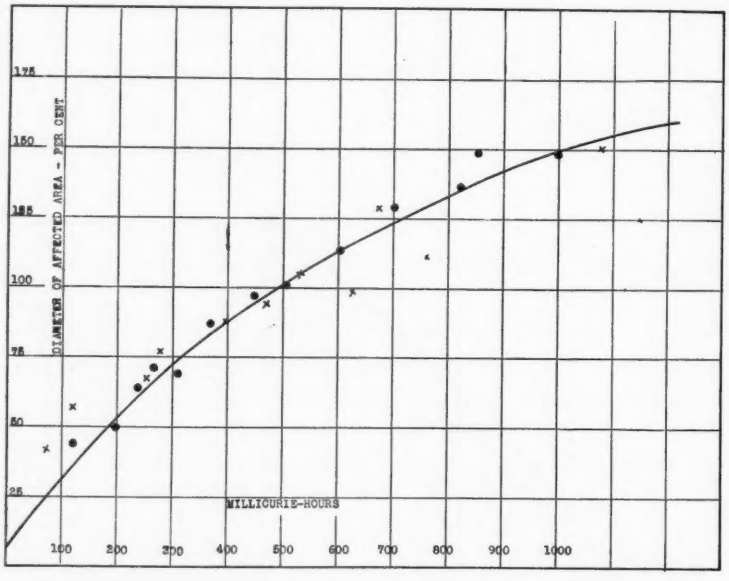


Fig. 6. Comparison of rabbit and butter gold seed data, on basis of variation of affected area with millicurie-hours. Line, butter data; points, rabbit data. (Circles, authors' data; crosses, Cutler's.)

Before it is possible to make comparisons between implants of different types it is necessary to investigate the effects of differences in length and filtration. A knowledge of the influences of these two factors will make it possible to correlate the effects of seeds and needles of different types, and to extend greatly the experimental basis for the calculation of tissue doses.

In Figure 8 are presented data for the effect of length of source on the bleached area in butter, the radon content and filter remaining constant. The sources were specially made gold seeds of varying lengths, each inserted into the butter when its strength was exactly 6.8 millicuries. Daily measurements were made, as usual, and the curves show the differences in areas for the four implants on different days, as indicated. If, now, for each day, the diameter for a 4-mm. seed be taken as 100 per cent, the diameters for other lengths can be calculated in percentages of this one. Then the percentage correction for change in length can be found. This is done in Table V. From this tabulation can be read the percentage correction to be applied to any implant longer than a gold seed to find the minimum diameter of the bleached area it would give after a given time. For example, on the second day, a needle 10 mm. long, having the same filtration and radon content as a given seed, would have a bleached area with a diameter only 73 per cent as large as that of the seed. It is evident that after the fifth day the ratios are practically constant. Therefore, when considering implants left in longer than this, a single average curve can be used. Such a curve is given in Figure 9.

TABLE V.—CHANGE IN DIAMETER OF BLEACHED AREA WITH LENGTH OF IMPLANT

Day	Diameter (per cent)						
	4 mm. long	6 mm. long	8 mm. long	10 mm. long	12 mm. long	14 mm. long	16 mm. long
2	100	89	79	73	67	62	58
4	100	92	85	79	74	71	68
6	100	93	88	83	79	76	74
8	100	94	89	84	81	79	77
10	100	94	89	85	81	79	77
12	100	94	89	85	82	80	77
15	100	94	89	85	82	80	77
20	100	94	89	85	82	80	77
Average after fifth day	100	94	89	85	82	79	77

These data can be considered in another way. If the experimental results are plotted to show the increase in diameter with time, for each length of implant, as in Figure 10, then the variation in the rate of increase can be observed. If the diameter for the tenth day, for each seed, be taken as 100 per cent, and those for the other days calculated in terms of this, this information can be condensed as in Table VI. From this table can be read the percentage increase from day to day for these particular implants. It is evident that, after a diameter of about 1 cm. has been reached, the *rate* of increase is the same regardless of the length of the source, within the limits of this experiment.

From these data it is apparent that, for any one type of implant, it is not necessary to make a correction for length while considering the rate of extension of a given effect around it. In correlating the effects of implants of different lengths, for lengths from 4 to 16 mm., it is possible to make a correction on the basis of the curves of Figures 8 and 9. For longer needles, or for bleached area diameters greater than about 2 cm., such corrections must be regarded as approximate.

It may be mentioned that the general curve of Figure 9 is in good agreement with one previously published for unfiltered sources (7). It is, therefore, permissible to use it for any type of filtered implant in use at the present time.

All of the data thus far given refer only to the diameter of the affected area, measured perpendicular to the implant at its center. The extent of the effect around a gold seed is nearly the same in all directions —the affected volume is nearly spherical. As the length of the implant increases, the volume becomes more markedly spheroidal. The actual amount of tissue affected, for a

TABLE VI.—CHANGE IN DIAMETER OF BLEACHED AREA WITH TIME, FOR IMPLANTS OF VARIOUS LENGTHS

Day	Diameter (per cent)				
	3.8 mm.	7.6 mm.	12.0 mm.	15.8 mm.	Average
2	54	49	45	38	46
4	72	68	67	54	68
6	85	83	82	81	83
8	93	93	93	92	93
10	100	100	100	100	100
12	106	106	106	106	106
15	112	113	113	112	112
20	118	120	118	117	118

given amount of radon, does not, however, vary greatly. In the case of the four implants considered above, the end-results are given in Table VII.

With regard to the effect of filtration of the seed, no direct experimental data are available. All the implants here considered had filters which were approximately the same. However, it may be pertinent to include here data previously published regarding the absorption of filtered radiation in tissue (9, 10). In Table VIII are given the relative amounts of radiation delivered at distances from seeds of different filtrations, having the same radon content. In this tabulation gold and platinum are grouped together, since they have practically the same filtration. Brass, steel, and monel metal are also grouped; they do not agree so closely, but may well be considered together for an approximation. The radiation from the standard seed, having a filter of 0.3 mm. of gold, is considered as 100 per cent for each distance. Distances less than 5 mm. have not been included; they are of little practical interest in interstitial therapy. Distances greater than 10 mm. give the same relative values as for that distance. It is evident from this tabulation that for any gold or platinum implants ordinarily used, it is not necessary to apply corrections for filters. On the other hand, for steel and monel metal needles, such a correction is quite important.

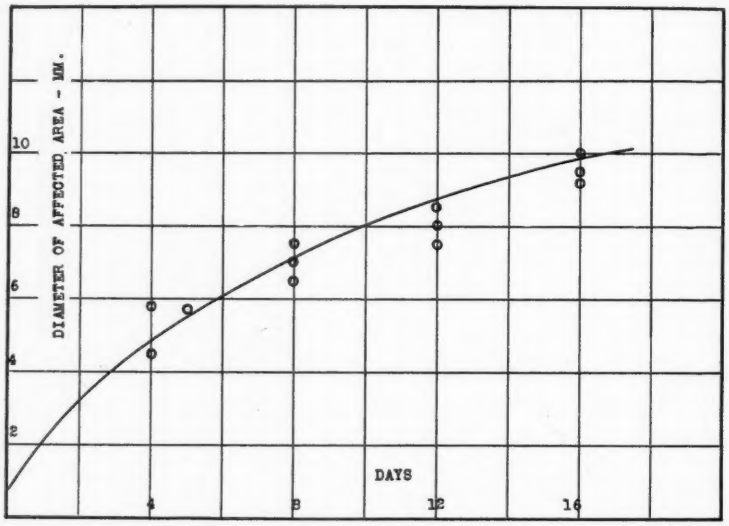


Fig. 7. Comparison of rabbit and butter data for 5-mg. needles, on basis of variation of affected area with days of irradiation. Line, butter; points, rabbits.

The data thus far presented have dealt with relatively small areas of butter discoloration—less than 2 cm. in diameter. For any single implant, the amount of energy delivered at any point within such a region will be much greater than that farther out. In general, volumes of greater diameter would not be treated with a single implant. However, the method of dosage measurement in use at the present time (1) is based upon evidence that the dose delivered at the periphery of a sphere from a definite amount of radon buried within it is the same whether the radon be concentrated at its

center or distributed uniformly within the inner half of the radius. From this point of view, it is evident that information of the sort here given should be extended to larger volumes. It has been possible to do this by means of implants other than seeds, namely, the radium needles already mentioned, and still farther by means of tubes containing 50 mg. of radium. These tubes were 20 mm. long, and had a wall of 0.5 mm. platinum. Data for the needles were obtained simultaneously with the gold seeds, as indicated in Figures 3-5; those for the tubes were obtained in a separate series of experiments, conducted in the same manner, but with much larger masses of butter and wax. In Table IV-A are given the average results for these sources, derived from several sets of experiments.

In Figure 11 the average gold seed curve of Table IV is plotted as a heavy line, and on it are placed points obtained for the 1-, 5-, and 10-mg. needles. These fall very closely on the curve as far as it goes. From the end of the gold seed curve a dotted line is carried through the remaining points for the needles, and is a smooth extension of this curve. In Figure 12 this extension of the 10-mg. needles is shown as a solid curve, and points obtained by means of 50-mg. tubes carry it on. The largest dose in Table IV-A represents a diameter of about 7 cm., obtained by the 50-mg. tubes in about the same length of time as the full extent of the

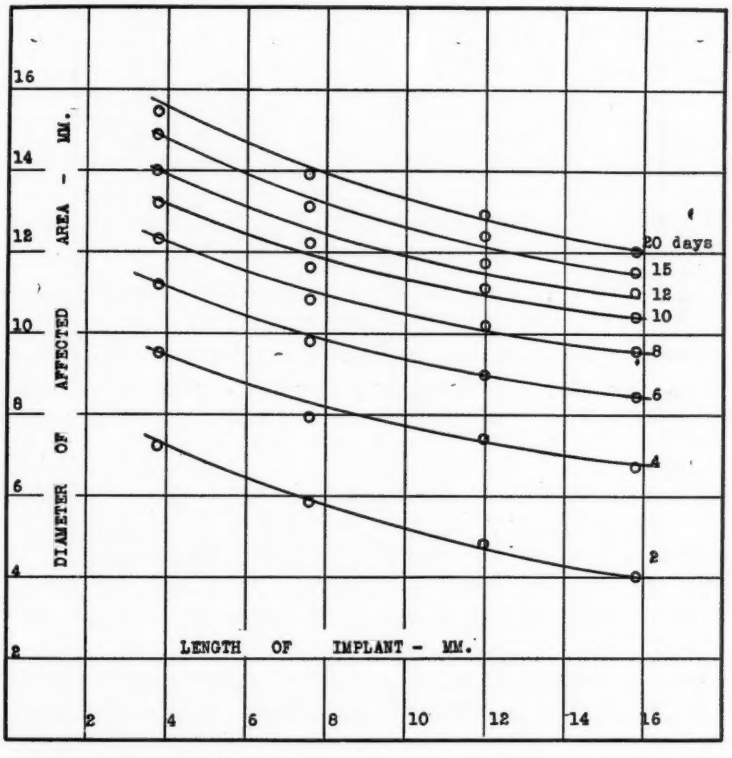


Fig. 8. Variation of diameter of affected area with length of implant, after different times of irradiation.

gold seed curve, namely, twenty days, the full length of the effective life of the seed.

In these figures no allowance is made for the length or filter of the successive sources —it is unnecessary. It has been shown that

able at the time that the tabulation was compiled. With the data now at hand a check on these dosages is possible. This may be obtained in two ways. In Figure 13-*A*, the percentage increase in diameter with milli-

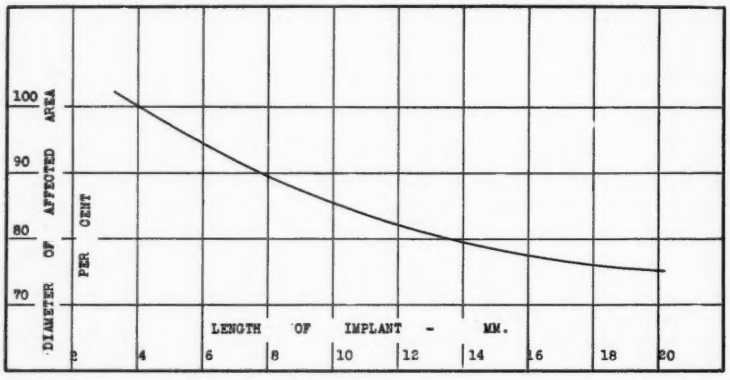


Fig. 9. General curve for variation of diameter of affected area with length of implant.

for any single implant within our experimental range of lengths, the *rate* of increase of the affected area is the same as for any other, after the first few millimeters, although the actual values of the diameters may differ considerably. The curves just given are plotted as percentage increases in diameters of affected regions. In order that they may be applicable to a definite problem, it is necessary to know this diameter for some single source of radiation.

At the Memorial Hospital there has been in use for some time a tabulation for determining the tissue doses due to gold seeds. Any single value from this tabulation would give the necessary information for making the curves just given of practical use. It is inserted here, as Table IX. The number of millicurie-hours necessary for any dose may be obtained from the millicurie value by multiplying the latter by 133. For the regions close to the seed, the values in this tabulation are based on extensive experimental work, but for greater distances than 1.5 cm. (3.0 cm. diameter) much less data were avail-

curie-hours according to the standard curve is shown as the solid line, and values obtained from the dosage table plotted as the points. They evidently agree exceedingly well. However, the actual affected volume expressed by the butter curve, within this millicurie-hour range, is much less than for the tissue. Accordingly, another type of comparison is shown in Figure 13-*B*. Here the distance in centimeters is plotted against the percentage change in dose necessary to produce a given effect. The line represents the butter bleaching, the points, the skin erythema dose, from the tabulation. Here a very small discrepancy is observed at the end, but in the main, the two agree. Certainly within the range in which the tabulation would normally be used for therapy, the experimental work here reported checks satisfactorily the tissue dose tabulation.

As stated at the beginning of this paper, the aim of the writers was to find a basis for comparing the tissue doses from removable and permanent implants of various types. It has now been shown that, for any specific

TABLE VII.—VARIATION IN VOLUME OF AFFECTED TISSUE WITH LENGTH OF SEED

Length of implant (mm.)	Dimensions of affected area (mm.)	Volume of affected area (cu. mm.)
3.8	15.5 × 16.0	2,020
7.6	13.9 × 19.6	1,980
12.0	12.9 × 22.0	1,920
15.8	12.0 × 25.6	1,860

type of implant within the range of the experiments here discussed, the effect depends on the millicurie- or milligram-hour dose. That is, equal tissue effects should be produced by equal millicurie- or milligram-hour doses, for like implants. For those of different types, a correction for length is necessary, and one for filtration may be desirable in certain cases.

The number of millicurie-hours delivered by a given source of radon in a given time can be obtained from the formula:

Mc.-hr. $= 133\ I_o\ (1\text{-}e^{-0.0075T})$ where I_o is the initial strength of the source, e the base of natural logarithms, T the time, in hours.

A simplified method of using this formula is developed in Figure 14. Here the time, in days or hours, is plotted against a number which represents the millicurie-hours divided by the initial strength of the source, that is, the millicurie-hours per millicurie. In other words, the number of millicurie-hours delivered by a 1-mc. source in any given time may be read directly from the curve. For any other the curve reading must be multiplied by the initial strength of the source. This curve may also be used to find the time necessary for a given source to deliver a specified number of millicurie-hours.

Some useful tabulations may be constructed giving relations between doses from different types of implants. In Table IX have been given the number of millicuries in gold seeds necessary to deliver different doses (in terms of skin erythema) at different distances, when the seeds are left in permanently. If removable seeds are to be used, Table X gives the lengths of time, for seeds of various strengths, to deliver the same dose. The same information, in somewhat different form, is given in Table XI, where the times for different seeds to deliver a specified number of millicurie-hours are listed.

These two tabulations may be used directly to compare doses for permanent and

TABLE VIII.—VARIATION IN INTENSITY OF RADIATION WITH FILTRATION, AT DIFFERENT DISTANCES FROM IMPLANTS (PERCENTAGE)

Distance	Filter					
	Glass seed	Steel, brass, or monel metal		Gold or platinum		
		0.25 mm.	0.5 mm.	0.2 mm.	0.3 mm.	0.5 mm.
5	204	135	118	105	100	95
6	178	125	116	103	100	96
7	162	123	115	102	100	97
8	153	122	114	102	100	97
10	136	121	114	102	100	97
15	136	120	114	102	100	97

TABLE IX.—MILLICURIES IN GOLD SEEDS REQUIRED TO DELIVER SPECIFIED DOSES TO MASSES OF VARIOUS DIAMETERS

Skin erythema doses	Diameter of mass (cm.)											
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0
	Number of millicuries											
1	0.2	0.5	0.8	1.5	2.0	2.4	2.9	3.4	4.0	5.4	7.0	9.0
2	0.4	1.0	1.6	3.0	4.0	4.8	5.8	6.9	8.0	11	14	18
3	0.6	1.5	2.4	4.5	6.0	7.2	8.7	10	12	16	21	27
4	0.8	2.0	3.2	6.0	8.0	9.6	12	14	16	22	28	36
5	1.0	2.5	4.0	7.5	10	12	14	17	20	27	35	45
6	1.2	3.0	4.8	9.0	12	14	17	20	24	32	42	54
7	1.4	3.5	5.6	10	14	17	20	24	28	38	49	63
8	1.6	4.0	6.4	12	16	19	23	27	32	43	56	72
9	1.8	4.5	7.2	14	18	22	26	31	36	49	63	81
10	2.0	5.0	8.0	15	20	24	29	34	40	54	70	90
11	2.2	5.5	8.8	17	22	26	32	37	44	59	77	99
12	2.4	6.0	9.6	18	24	29	35	41	48	65	84	108
13	2.6	6.5	10	20	26	31	38	44	52	70	91	117
14	2.8	7.0	12	21	28	34	41	48	56	76	98	126
15	3.0	7.5	13	23	30	36	44	51	60	81	105	135

TABLE X.—DAYS FOR REMOVABLE RADON SEEDS TO DELIVER SAME DOSES AS PERMANENT SEEDS OF VARIOUS STRENGTHS

Permanent seeds		Days for removable seeds of same dimensions								
Initial mc.	Mc.-hr.	1 mc.	2 mc.	3 mc.	4 mc.	5 mc.	6 mc.	8 mc.	10 mc.	12 mc.
0.25	38	1.9	0.9	0.6						
0.50	67	3.9	1.9	1.0	0.8	0.6				
0.75	100	7.8	2.7	1.6	1.2	1.0	0.8	0.5		
1.0	133	perm.	3.9	2.2	1.6	1.3	1.0	0.8	0.6	
1.5	200		7.8	3.9	2.7	2.0	1.6	1.2	1.0	0.8
2.0	267		perm.	6.0	3.9	2.8	2.5	1.6	1.3	1.0
2.5	333			10.0	5.4	3.9	3.0	2.1	1.6	1.3
3.0	400			perm.	7.8	5.1	3.9	2.7	2.0	1.6
3.5	466				11.9	6.7	4.8	3.1	2.4	2.0
4.0	532				perm.	8.9	6.2	3.9	2.8	2.3
5.0	665					perm.	10.0	5.4	3.9	3.0
6.0	800						perm.	7.8	5.1	3.9
7.0	932							11.9	6.7	4.6
8.0	1,064							perm.	8.9	5.0
10.0	1,330								perm.	10.0
12.0	1,600									perm.

removable implants of the same dimensions. In conjunction with Table IX they may be used to determine the dose delivered at any point in the tissues, for permanent or removable gold or platinum implants of the type ordinarily used (4-5 mm. in length, 0.25-0.4 mm. gold or platinum walls). For longer gold or platinum implants a correction for length is necessary, and for steel and monel metal needles, an additional one for filtration. In Table XII are tabulated the times necessary for various types of implants to give equivalent doses (at a distance of 1 cm. from the implant, on a line perpendicular to its center). These are all related to the same gold seeds as those in Table X.

All the doses on any horizontal line are equivalent. The data in this tabulation can be compared with those for removable implants by means of Table X.

It may be well to outline briefly the method of applying the corrections for length and filter to obtain the data for this tabulation. This can best be done by means of illustrations. As an example of the correction for length, let us obtain the factor for a 10-mm. implant having the same filtration as the standard one of 4 mm. length. From Figure 9, it is seen that a 10-mm. implant affects a volume having a minimum diameter only 85 per cent as large as one affected by the 4-mm. seed, and it will require a correspondingly larger dose to affect a volume having the same minimum diameter. This dose, however, is not in the ratio of 100 to 85. It is the dose which, if given with a 4-mm. implant, would be effective to a diameter larger in this ratio. That is, if a given 4-mm. seed produces a specified effect at a given distance, then for a 10-mm. implant to produce the same effect at the same distance, it will be necessary to use the dose specified for the 4-mm. seed at a distance of 100/85, or 118 per cent as great. This can be found from Figure 11. Here, for a diameter of 100 per cent, the dose is 500 mc.-hr. and for 118 per cent, 660 millicurie-hours. All the doses for the 10-mm. implant, then, must be higher than those for the 4-mm. one in this ratio of 660/500, or 32 per cent higher. This holds for any 10-mm. implant, whether it contains radium or radon. If it contains radium, the time required to deliver the dose can be found immediately by dividing the mg.-hr. by the strength of the source. If it contains radon, the time must be found from Figure 14. These data must not be construed as stating

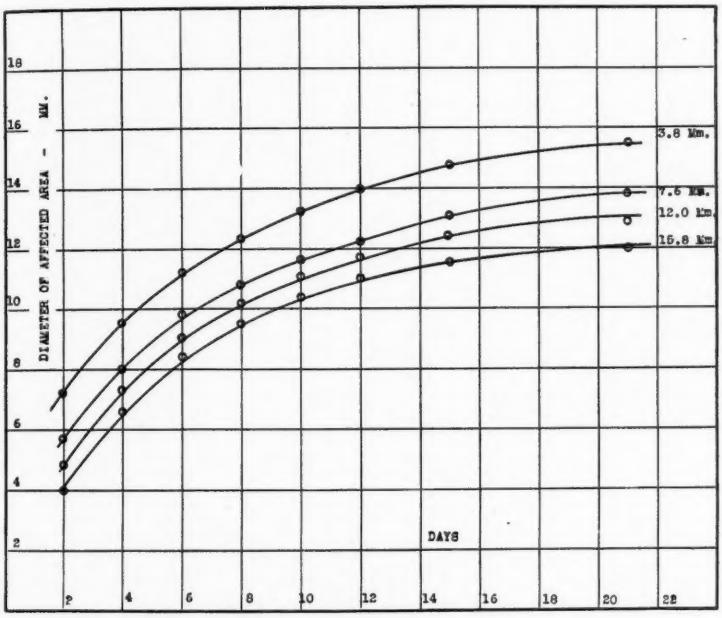


Fig. 10. Variation in diameter of affected area with time, for implants of different lengths.

TABLE XI.—DAYS FOR REMOVABLE RADON IMPLANTS TO DELIVER SPECIFIED DOSES

Mc.-hr.	Days								
	1 mc.	2 mc.	3 mc.	4 mc.	5 mc.	6 mc.	8 mc.	10 mc.	12 mc.
25	1.2	0.5							
50	2.6	1.2	0.8	0.5					
75	4.6	1.9	1.2	0.9	0.7	0.5			
100	7.9	3.8	1.6	1.2	1.0	0.8	0.5		
150		4.6	2.6	1.9	1.5	1.2	0.9	0.7	0.5
200		7.9	3.9	2.7	2.0	1.6	1.2	1.0	0.8
250		15.4	5.4	3.5	2.6	2.1	1.6	1.2	1.0
300			7.9	4.6	3.3	2.7	1.75	1.45	1.2
400			30.0	7.9	5.1	3.9	2.7	2.0	1.6
500				15.5	7.9	5.4	3.5	2.7	2.1
600					12.7	7.9	4.6	3.3	2.7
700						10.0	6.0	4.2	3.5
800						30.0	7.9	5.1	3.9
900							10.6	6.3	4.6
1000							15.6	7.9	5.4
1100								9.9	6.5
1200								12.7	7.9
1300								23.3	9.9
1400									12.0
1500									30.0

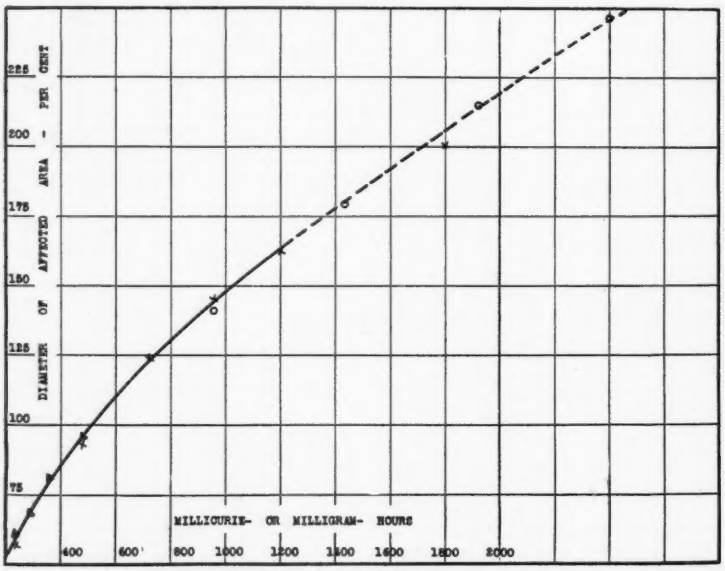


Fig. 11. Comparison of variation in diameter of affected area with mc.- or mg.-hr. for different types of implant. Solid line, gold radon seeds; points and dotted line, platinum radium needles. (Triangles, 1 mg.; crosses, 5 mg.; circles, 10 mg.)

that under the conditions of the tabulation the same dose is delivered to *equal volumes* of tissue. It is delivered at the same distance perpendicular to the middle of the implant.

TABLE XII.—DOSES AND TIMES OF IRRADIATION NE

Radon in gold or platinum 0.3 mm. filter						Radium in gold or pl									
4-mm. seeds left in permanently		10-mm. seeds 5 mc. initial		20-mm. seeds 5 mc. initial		1-mg. needle 5 mm. long		1-mg. needle 10 mm. long		2-mg. needle 10 mm. long		5-mg. needle 10 mm. long		5-mg. needle 15 mm. long	
Initial mc.	Mc.-hr.	Mc.-hr.	Days	Mc.-hr.	Days	Mg.-hr.	Days	Mg.-hr.	Days	Mg.-hr.	Days	Mg.-hr.	Days	Mg.-hr.	Days
0.25	38	56	0.5	78	0.7	43	1.8	56	2.3	56	1.15	56	0.5	70	0.6
0.50	67	94	0.9	118	1.1	75	3.1	94	3.9	94	2.0	94	0.8	110	0.9
0.75	100	133	1.3	160	1.5	108	4.5	133	5.5	133	2.8	133	1.1	152	1.3
1.0	133	170	1.7	205	2.1	138	5.8	170	7.1	170	3.6	170	1.4	194	1.6
1.5	200	255	2.7	300	3.3	212	8.8	255	10.6	255	5.3	255	2.1	288	2.4
2.0	267	337	3.9	407	5.2	278	11.6	337	14.0	337	7.0	337	2.8	382	3.2
2.5	333	415	5.4	520	8.5	348	14.5	415	17.3	415	8.6	415	3.5	485	4.0
3.0	400	510	8.5	635	17.0	424	17.7	510	21.7	510	10.8	510	4.3	598	5.0
3.5	466	600	12.8			493	20.6	600	25.0	600	12.5	600	5.0	700	5.8
4.0	532									695	14.3	695	5.8	800	6.7
5.0	665									875	18.2	875	7.3	1,020	8.5
6.0	800									1,085	20.3	1,085	9.0	1,245	10.4
7.0	932											1,260	10.5	1,465	12.2
8.0	1,064											1,435	12.0	1,675	14.0
10.0	1,330											1,780	14.8	2,100	17.5
12.0	1,600											2,180	18.2	2,450	21.2
15.0	2,000											2,700	22.6	3,100	25.8

ADIATION NECESSARY FOR VARIOUS IMPLANTS TO PRODUCE THE SAME EFFECT AT A DISTANCE O

m in gold or platinum 0.3 mm. filter

5-mg. needle 15 mm. long		5-mg. needle 20 mm. long		7.5-mg. needle 15 mm. long		7.5-mg. needle 20 mm. long		10-mg. needle 15 mm. long		10-mg. needle 20 mm. long		2-mg. needle 10 mm. long (2.4 mg. equiv.)		5-mg. n 10 mm. (6 mg.
Mg.-hr.	Days	Mg.-hr.	Days	Mg.-hr.	Days	Mg.-hr.	Days	Mg.-hr.	Days	Mg.-hr.	Days	Mg.-hr.	Days	Mg.-hr.
70	0.6	78	0.65	70	0.4	78	0.4	70	0.3	78	0.3	47	1.0	47
110	0.9	118	1.0	110	0.6	118	0.7	110	0.4	118	0.5	78	1.6	78
152	1.3	160	1.35	152	0.8	160	0.9	152	0.6	160	0.7	111	2.3	111
194	1.6	205	1.7	194	1.1	205	1.2	194	0.8	205	0.9	142	3.0	142
288	2.4	300	2.5	288	1.6	300	1.7	288	1.2	300	1.2	213	4.4	213
382	3.2	407	3.4	382	2.1	407	2.3	382	1.6	407	1.7	281	5.8	281
485	4.0	520	4.3	485	2.7	520	2.9	485	2.0	520	2.2	346	7.2	346
598	5.0	635	5.3	598	3.3	635	3.5	598	2.5	635	2.6	425	9.0	425
700	5.8	750	6.2	700	3.9	750	4.2	700	2.9	750	3.1	500	10.4	500
800	6.7	864	7.2	800	4.4	864	4.8	800	3.4	864	3.6	580	12.1	580
1,020	8.5	1,105	9.3	1,020	5.7	1,105	6.1	1,020	4.2	1,105	4.6	730	15.2	730
1,245	10.4	1,340	11.2	1,245	6.9	1,340	7.4	1,245	5.2	1,340	5.6	900	18.8	900
1,465	12.2	1,570	13.0	1,465	8.1	1,570	8.7	1,465	6.1	1,570	6.5	1,050	22.0	1,050
1,675	14.0	1,790	14.9	1,675	9.3	1,790	10.0	1,675	7.0	1,790	7.4	1,200	25.0	1,200
2,100	17.5	2,275	19.0	2,100	11.7	2,275	12.7	2,100	8.8	2,275	9.5			1,480
2,450	21.2	2,620	21.8	2,450	13.6	2,620	14.6	2,450	10.6	2,620	10.9			1,800
3,100	25.8	3,300	27.5	3,100	17.2	3,300	18.4	3,100	12.9	3,300	13.8			2,170

ANCE OF ONE CENTIMETER IN TISSUE

Radium in steel or monel metal

0.25 mm. filter						0.5 mm. filter							
5-mg. needle 10 mm. long (6 mg. equiv.)		5-mg. needle 15 mm. long (6 mg. equiv.)		10-mg. needle 20 mm. long (12 mg. equiv.)		2-mg. needle 10 mm. long (2.3 mg. equiv.)		5-mg. needle 10 mm. long (5.75 mg. equiv.)		5-mg. needle 15 mm. long (5.75 mg. equiv.)		10-mg. needle 20 mm. long (11.5 mg. equiv.)	
Mg.-hr.	Days	Mg.-hr.	Days	Mg.-hr.	Days	Mg.-hr.	Days	Mg.-hr.	Days	Mg.-hr.	Days	Mg.-hr.	Days
47	0.4	58	0.5	65	0.3	49	1.0	49	0.4	61	0.5	68	0.3
78	0.6	92	0.8	99	0.4	82	1.7	82	0.7	96	0.8	104	0.4
111	0.9	127	1.1	134	0.6	116	2.4	116	1.0	132	1.1	139	0.6
142	1.2	162	1.3	172	0.7	149	3.1	149	1.3	170	1.4	180	0.7
213	1.8	240	2.0	252	1.0	223	4.6	223	1.9	251	2.1	263	1.1
281	2.3	318	2.7	342	1.4	295	6.1	295	2.4	332	2.8	356	1.5
346	2.9	405	3.3	436	1.8	364	7.5	364	3.0	423	3.5	456	1.9
425	3.6	498	4.2	533	2.2	446	9.4	446	3.8	520	4.3	557	2.3
500	4.1	588	4.9	630	2.6	525	10.9	525	4.3	615	5.1	658	2.7
580	4.8	672	5.6	725	3.0	608	12.6	608	5.0	702	5.8	756	3.1
730	6.1	855	7.1	930	3.8	765	15.9	765	6.3	895	7.4	970	4.0
900	7.5	1,040	8.6	1,125	4.6	944	19.7	944	7.9	1,090	9.0	1,175	4.8
1,050	8.8	1,230	10.2	1,320	5.5	1,100	23.0	1,100	9.1	1,285	10.6	1,380	5.7
1,200	10.0	1,400	11.6	1,500	6.2			1,260	10.4	1,465	12.1	1,570	6.5
1,480	12.4	1,760	14.6	1,910	7.9			1,550	12.9	1,840	15.2	2,000	8.2
1,800	15.2	2,050	17.0	2,200	9.1			1,890	15.8	2,145	17.7	2,300	9.5
2,170	18.8	2,600	21.6	2,775	11.5			2,270	19.5	2,720	22.4	2,900	12.0

UNIV OF MICH.

Evidently the longer implant will deliver the effective dose to a greater volume of tissue.

For the correction for filtration, the factors of Table VIII are used. As a first approximation, the factor chosen is the one for a distance of 1 centimeter. This is reasonable, since the factors are practically constant from then on, and also since it is the distance at which the length factors become constant. The effect of the correction is to make the source practically stronger in the given ratio. Thus, for a 0.5-mm. steel needle, the intensity of radiation after passing through 1 cm. of tissue is 114 per cent that from 0.3 mm. of gold or platinum. That is, in comparison to the gold, the steel-filtered source is 114 per cent as effective. This does not mean, however, that it affects a volume 114 per cent as great in diameter. It means that its effective strength is 14 per cent greater. Thus a 5-mg. needle in 0.5 mm. of steel would have an effective strength of 1.14×5, or 5.7 as compared to one of the same amount of radium in 0.3 mm. gold. The relative diameters of the affected regions can be found from Figure 11. For example, if the 5-mg. needle in 0.3 mm. gold (or platinum) be used for 100 hours, to deliver 500 mg.-hr., the diameter is specified as 100 per cent. If the "effectively" 5.7-mg. needle be used for the same length of time, to give an effective 570 mg.-hr., the diameter is 108 per cent. This is the increase due to the thinner filter. Since this shows the thinner filters to be relatively more efficient, it must be remembered that the tabulation says nothing about the identity of the two effects except at the peripheries of the regions under consideration. It does not take into account the greater intensity inside this region, for implants with thinner filters (possible necrosis, etc.).

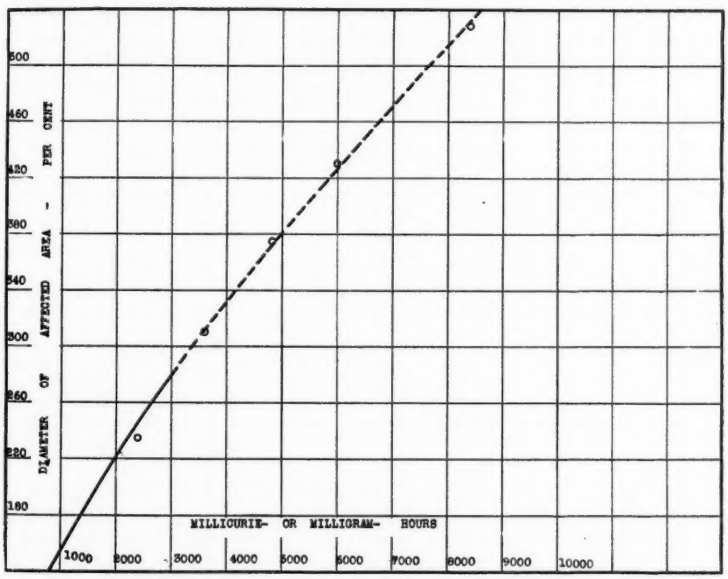


Fig. 12. Continuation of curve of Figure 11. Solid line, 10-mg. needles; points and dotted line, 50-mg. tubes.

SUMMARY

Experimental data are presented regarding the effects of certain permanent and removable radon and radium implants, in pro-

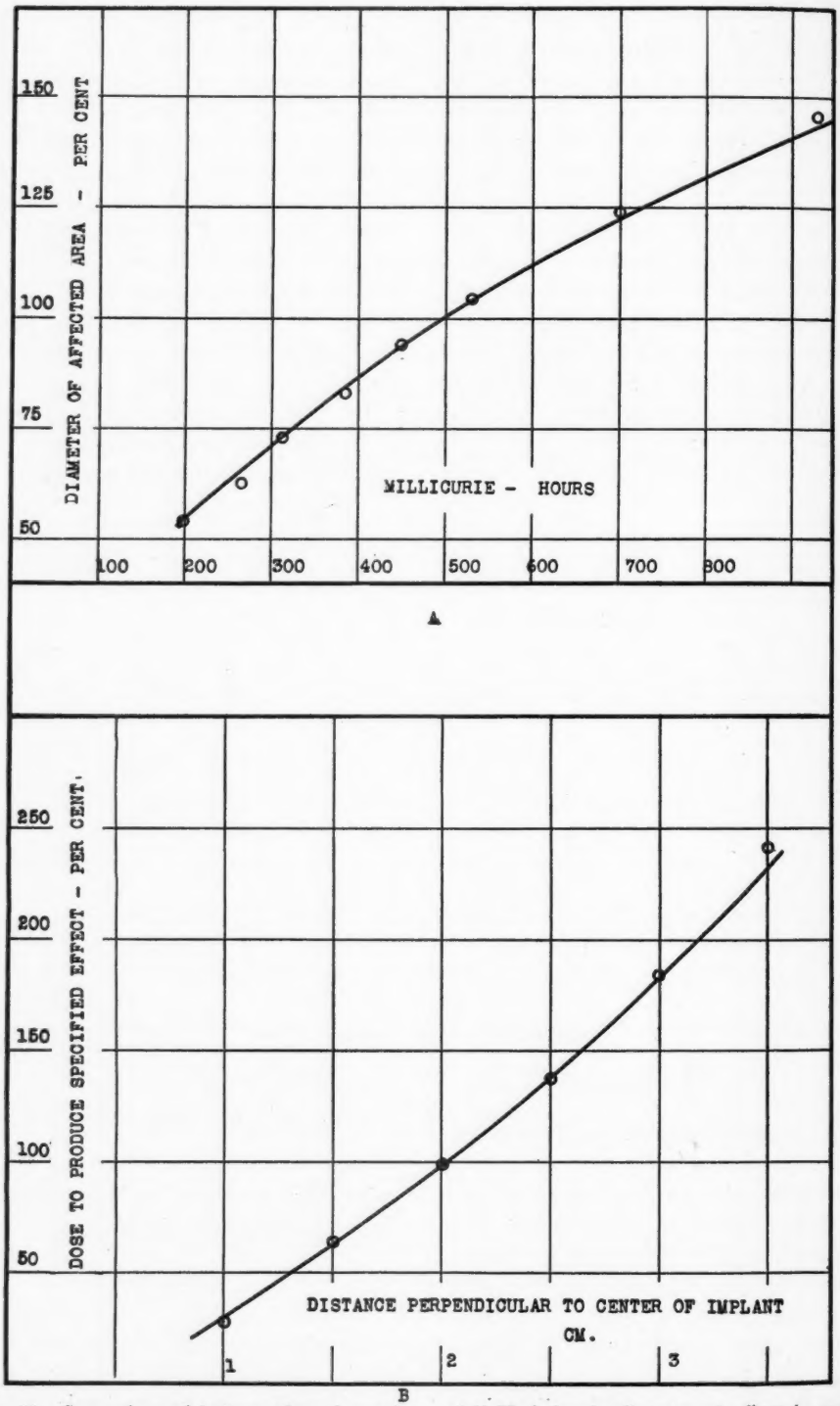


Fig. 13. Comparison of butter and erythema data: *(A)* Variation in diameter of affected area with millicurie-hours. Line, butter; points, erythema. *(B)* Variation in dose necessary to produce a specified effect with distance. Line, butter; points, erythema.

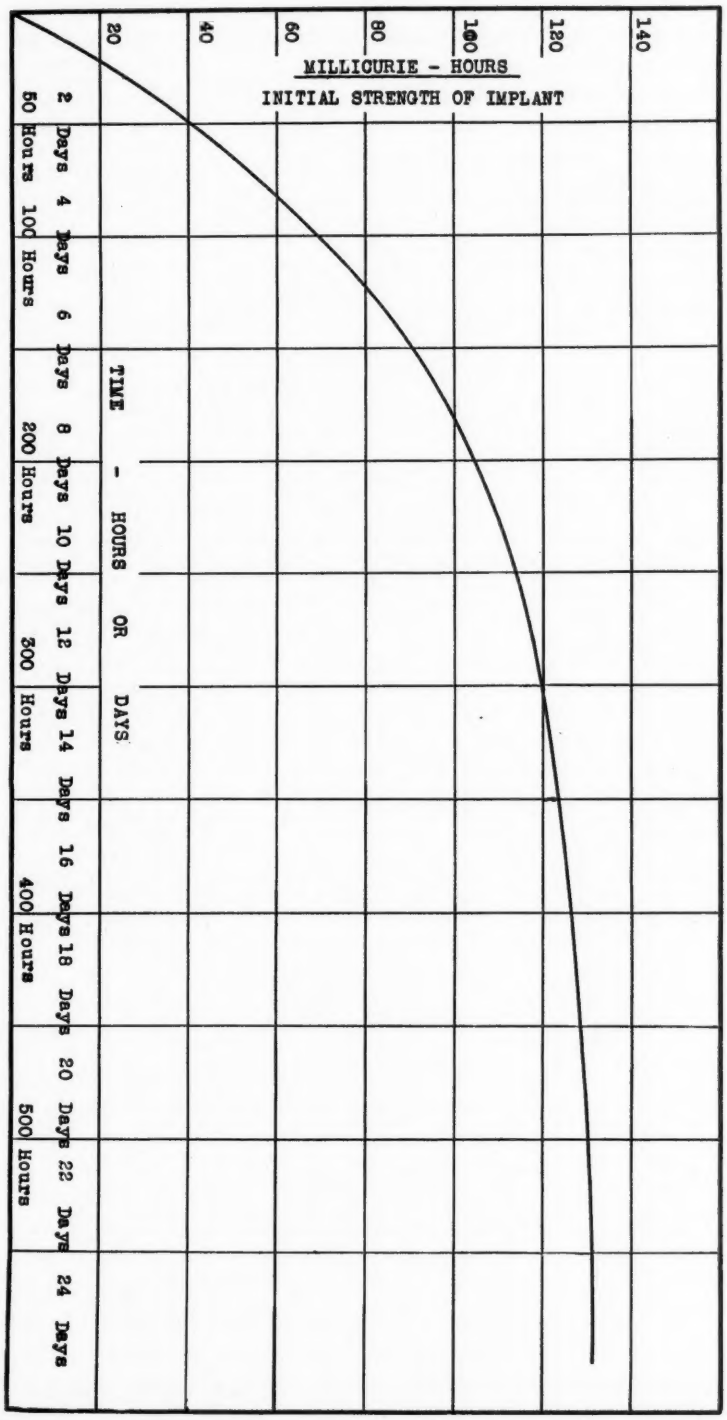


Fig. 14. Curve showing relation between time of irradiation and millicurie-hours delivered, for radon.

ducing necrosis in rabbit muscle and bleaching in butter.

These data are shown to agree as to the *rate* at which the effects are produced in the two media, for the implants considered, provided comparisons are made on a basis of milligram- or millicurie-hours, and not on that of initial millicurie strength.

It is shown that data obtained from butter experiments can be used to determine tissue doses, as a satisfactory first approximation.

Methods are developed for making proper allowance for variations in length and filtration of implants, within the range ordinarily used in therapy.

On a basis of these experimental data, extensive correlations are made between a variety of permanent and removable implants of different sizes, strengths, and filtrations. Tabulations are given showing the time necessary to deliver specified doses from these various sources.

The authors wish to acknowledge their indebtedness to Dr. G. Failla, who suggested the problem, for his interest and valuable suggestions during the course of the work. They also wish to express their appreciation to Mr. Marinelli and Mr. Rose, of the Radium Department, for their assistance in preparing and measuring the sources of radon used in the experimental work.

BIBLIOGRAPHY

(1) Quimby, E. H., and Martin, H. E.: A Basis for Dosage Determination in Interstitial Irradiation. Am. Jour. Roentgenol. and Rad. Ther., March, 1929, XXI, 240-249.

(2) Martin, H. E., Quimby, E. H., and Pack, G. T.: Calculations of Tissue Dosage in Radiation Therapy. Am. Jour. Roentgenol. and Rad. Ther., April, 1931, XXV, 490-506.

(3) Quimby, Edith H.: A Comparison of Radium and Radon Needles and Permanent Radon Implants. Am. Jour. Roentgenol. and Rad. Ther., January, 1930, XXIII, 49-56.

(4) Failla, G.: The Development of Filtered Radon Implants. Am. Jour. Roentgenol. and Rad. Ther., December, 1926, XVI, 507-525.

(5) Quimby, Edith H.: The Intensity of Radiation in the Vicinity of Filtered Radon Implants. Radiology, May, 1928, X, 365-376.

(6) Cutler, Max: Comparison of the Effects of Unfiltered and Filtered Radon Tubes Buried in Rabbit Muscle. Am. Jour. Roentgenol. and Rad. Ther., December, 1926, XVI, 535-543.

(7) Failla, G., Adair, Frank, Quimby, Edith H., Sugiura, Kanematsu, Arnell, John C., and Goldsmith, Norris W.: Dosage Study Relative to the Therapeutic Use of Unfiltered Radon. Am. Jour. Roentgenol., and Rad. Ther., January, 1926, XV, 1-35.

(8) Lacassagne, A.: Recherches experimentales sur l'action des rayonnements beta et gamma du radium agissant dans les tissus par radiopuncture. Jour. de Radiol. et d'électrol., 1921, V, 160.

(9) Failla, G.: The Absorption of Radium Radiations by Tissues. Am. Jour. Roentgenol. and Rad. Ther., May, 19,1, VIII, 215-232.

(10) Quimby, Edith H.: Comparison of Different Metallic Filters Used in Therapy. Am. Jour. Roentgenol. and Rad. Ther., April, 1925, XIII, 330-342.

EXPERIMENTS AND EXPERIENCES WITH VARIOUS CONTRAST MEDIA IN EXCRETION UROGRAPHY[1]

By A. C. SIEFERT, M.D., Department of Roentgenology, Merritt Hospital, Oakland, California

THE roentgenographic visualization of the urinary tract by means of a contrast medium injected into the circulation to be excreted by the kidneys has been an intriguing problem for many years. It seemed near its solution after Graham and his associates had done their brilliant work on cholecystography, and even nearer when Rowntree and his collaborators had demonstrated the feasibility in principle of intravenous urography by the intravenous injection of large doses of sodium iodide. Certainly, it seems unfortunate that these American investigators, with all the prerequisites to the successful solution of the problem right in their hands, did not add excretion urography to the list of their achievements some seven years ago. It was, however, left to Roseno, of Cologne, Germany, to accomplish this five years later, and, if not altogether satisfactorily, to point out the road which further development has had to travel in order to achieve success.

Pyelognost, the contrast medium used by Roseno, is a chemical combination of sodium iodide with urea. In the elaboration of his method, as indicated in his publications, Roseno based his considerations on the discoveries of Graham and of Rowntree. These considerations were pharmacologic and roentgenologic on the one hand, and physiologic with reference to the urinary system on the other. The substance to be employed for excretion urography must first of all be non-toxic when injected into the blood stream, and must be readily soluble in water. Von Lichtenberg's failure in attempting to elaborate a method of intravenous urography almost a generation ago was due to the fact that a water-soluble non-toxic medium could not be found at that time. As a carrier of the shadow-casting properties, roentgenologically speaking, he had considered the heavy metallic atoms such as silver and thorium in the molecules of substances to be used, but not the heavier ones of the halogens. Roseno, on the other hand, selected iodine with an atomic weight of 126 to satisfy roentgenographic requirements. Sodium iodide in sufficient dosage to meet such requirements, however, is toxic, but this investigator reasoned that in combination with another substance this toxicity might be reduced, if not entirely abolished. As will be seen, he was in a large measure correct in this assumption.

Concerning the physiologic requirements of his contrast medium Roseno argued as follows: It would be necessary, first of all, to combine the shadow-casting substance with one that of necessity would act as a vehicle to the kidney, just as Graham's tetraiodophenolphthalein of necessity carries the shadow-casting iodine atoms in its molecule to the liver. Urea answered these requirements beautifully. Urea had also another property which was essential to success—it acted as a strong diuretic. The kidney drainage system, under which term is designated the kidney pelvis with its calices, is, unlike the gall bladder, not an organ for storage and concentration of a fluid, nor even, like the urinary bladder, for storage simply, but its purpose is, as indicated, drainage. The urine distills from the papillæ drop by drop into the minor calices and is thence immediately carried off to the bladder by peristaltic activity, never under normal conditions distending the calices and kidney pelvis. Accordingly, to unfold this drainage

[1]Read before the Radiological Society of North America at the Sixteenth Annual Meeting, at Los Angeles, Dec. 1 to 5, 1930.

system and distend it with shadow-casting urine, it is necessary, so argued Roseno, to flood it suddenly and rapidly. That his reasoning was correct he was able to show by animal and clinical experiments, as will be discussed and illustrated farther on in this paper. The properties thus making pyelognost a suitable medium for intravenous urography are possessed by the newer media also, *i.e.*, uroselectan and abrodil-skiodan. The question at present is simply one of relative toxicity.

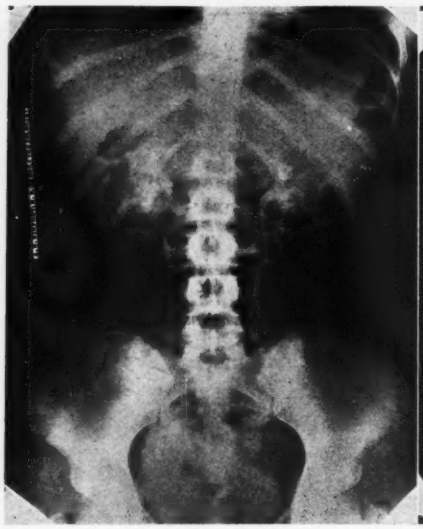


Fig. 1. Female, aged 14 years. Roentgenogram taken 15 minutes after intravenous injection of 25 grams of uroselectan. Urinary system normal. Note distention of drainage system and loop in left ureter.

Fig. 2. Same case as shown in Figure 1. Roentgenogram one hour after injection of uroselectan. Note the greater delicacy of the pyelograms and the disappearance of the loop in the left ureter.

In the late Fall of 1929 it was possible to obtain one-half dozen packages of pyelognost from Germany. It is a white, crystalline, very hygroscopic powder, readily soluble in water. The solution is clear, like water, with a faint yellowish cast. The chemical formula of pyelognost is (NaI. CO $(NH_2)_2$), and it contains 60 per cent iodine by weight. The dose for the human adult of from 65 to 75 kilograms body weight is given as 63 grams. This would mean a dose of 38 grams of iodine in every dose of pyelognost. The sodium iodide is comparatively loosely bound and, it is said, may possibly be split off in the body. Roseno warns that iodine-sensitive patients as well as patients suffering from Graves' disease, pulmonary tuberculosis, etc., be excluded from the test. In spite of the fact that Roseno has used the drug clinically in perhaps over 200 cases, yet it has not found the response that it would have received had it not been for its comparative toxicity.

Animal experiments were made with pyelognost by Mr. George Giragosintz, assistant in the pathological laboratory at Merritt Hospital. For the purpose of determining the toxicity of the drug, dogs, rabbits, and white rats were employed. In order to approach closely the conditions governing the administration of pyelognost to the average human adult a dose of 1.2

gram per kilogram of body weight, injected intravenously in a concentration of 63 per cent, was taken as a normal dose. It was found that twice such a dose was lethal to dogs and rabbits, while three and in some cases four times the normal dose was necessary to kill the white rats. In the dogs severe shock, dominated by difficulties in respiration, resulted in death of the animals within six hours of the injection. In rabbits the outstanding symptoms were ascending spinal paralysis, ending in death within twenty-four hours from respiratory failure. Most resistant were the white rats, as indicated above.

In trying to find an explanation for such marked toxicity the chemical stability of pyelognost was subjected to examination, especially as to whether iodine could be easily split off in the test tube, or was split off in the body. It was found that the compound was quite stable and that no ionic iodine was demonstrable in the blood or the urine of animals to which the drug had been administered. As these experiments with pyelognost are now viewed in retrospect it seems probable that the extremely toxic action of the drug was in great part due to marked hypertonicity of the solution used. Pyelognost is isotonic with the blood at 3.5 per cent. Nevertheless, the drug can not be entirely exonerated of toxicity in itself. It is intended, however, to do further experiments to determine this question. Perhaps pyelognost has not received a fair and exhaustive trial. Reduction of dosage would have been, in view of the high iodine content of this contrast medium, a feasible procedure, also the injection of less concentrated solution. Both together might have solved the problem. Pyelognost was too soon replaced by something better—"uroselectan."

The apparently marked toxicity of pyelognost discouraged its use in the human subject. At that time the now famous work of Swick, von Lichtenberg, and Lichtwitz came

Fig. 3. Same case as shown in Figures 1 and 2. Roentgenogram taken immediately after the preceding (Fig. 2) and after emptying of bladder. Note how the contrast medium is flowing from the kidney pelves and calices. At six hours after injection no shadow-casting material remained in the urinary tract.

to attention, and when Dr. Swick in a personal letter gave assurance that a new medium, "uroselectan," was absolutely safe and non-toxic, even in large doses, it was resolved to drop the idea of using pyelognost clinically, and to wait until uroselectan should become commercially available.

Uroselectan is chemically the sodium salt of 5-iodo-2-oxy-pyridine-nitro-acetic acid. A single atom of iodine is bound directly to the pyridin ring and, hence, not readily split off. Its iodine content is 42 per cent; 17 grams of iodine are, therefore, administered in the normal dose to an adult of from 150 to 180 pounds weight, the dose of uroselectan being 40 grams. Uroselectan is readily dissolved in distilled water, yielding a clear straw-colored solution.

In spite of the published and personal assurance of Dr. Swick as to the safety of uroselectan, it was, nevertheless, thought wise to determine its toxicity by animal ex-

periments, especially in consideration of experiences with pyelognost. It was possible to give four times the relative dose per kilo of body weight without ill effects on the animals.

Fig. 4. Male, aged 21 years. Roentgenogram taken 15 minutes after intravenous injection of 40 grams of uroselectan. Note marked pyelectasis of left kidney due to ureteral stricture. Note also the over-distention of the kidney drainage system on the right side.

Fig. 5. Same case as shown in Figure 4. Roentgenogram taken one hour after injection of uroselectan. Note greater delicacy of the normal pyelogram on the right (reversed).

Accordingly the use of uroselectan in human subjects was begun, and it is the drug with which the great majority of the writer's clinical experiences have been gained.

The first clinical administration of the drug taught, by means of a severe reaction, a great deal about how to avoid such reactions in the future, and it may be of value to recount the experience in detail. The solution injected consisted of 40 grams of the drug dissolved thoroughly in 110 c.c. of triple distilled water, properly filtered, and sterilized by boiling on the water bath for twenty minutes. Prior to use, it was tested for free iodine, which test was negative. This solution was injected by the gravity method into the patient's right cubital vein. The gravity apparatus had been washed out with normal saline. After a few cubic centimeters had run into the vein the patient began to complain of pain locally, radiating toward the shoulder. This pain increased until, when about 50 c.c. of the uroselectan solution had been injected, it became unbearable. The needle was accordingly withdrawn, but, there being no facilities at hand for washing out the vein with normal saline solution, it was allowed to go. The patient subsequently developed a thrombophlebitis in this vein. The remaining half of the drug was then injected into the cubital vein of the left arm, and well washed in with the normal saline. No phlebitis developed in this vein. The patient, after having received the entire dose, went suddenly into a state of mild shock characterized by pallor, cold clammy skin, tachycardia, weak thready

pulse, and labored respiration. Subjectively he complained of a feeling of inability to take a breath. This symptom was particularly alarming because of its similarity to what had been observed in the dogs injected with pyelognost. This reaction lasted about five minutes and yielded finally to the administration of stimulants and heat. The lesson drawn from this experience was that the injection into the circulation of markedly hypertonic solutions is dangerous, the writer being convinced that uroselectan of itself is not toxic in the dosage employed. He has since then acted upon this conviction and never injected the drug in a concentration greater than 15 per cent. At this concentration the drug, moreover, may be injected much more rapidly, which is an advantage, as shall be shown, and one gets positively no reaction. The drug has thus been given to children as well as to old persons without eliciting unpleasant phenomena, and the case is not overstated when it is said that the majority of reactions are due to marked hypertonicity of the solution injected. (It may be stated here incidentally that uroselectan is isotonic with the blood in a watery solution of 4.5 per cent concentration, according to our own determination.) It is possible also, by injection of dilute solutions, to avoid the pain in the arm, and the washing out of the vein with normal saline will not be so important. A slight feeling of warmth during administration of the drug is the only symptom not yet overcome.

Uroselectan is excreted by the glomeruli, according to work done on the frog's kidney by von Lichtenberg's assistants, Hughes and Schaffhauser, under the guidance of Peterfi. One of the writer's patients, a child of 8 with a mild subacute glomerulo-nephritis, excreted only 25.7 per cent of the substance in six hours. When the glomerular system is extensively damaged, other organs, notably the liver, are slated to carry out the excretion of the contrast medium. The excretion in the normal kidney takes place with a thrust. The kidney drainage system is suddenly flooded and distended with urine containing the contrast medium in varying concentration, but evidently never exceeding a certain maximum, which for uroselectan is about 5 per cent. (According to our determination 2.5 per cent is the average maximum.) We intend to study this further experimentally. The writer has noticed in normal adolescents and young adults, in whom one would expect the kidney function to be at its best, that the most distinct and dense pyelograms are obtained, whereas in individuals past middle age the excretion of the contrast medium is evidently in diminished concentration, and there is not as a rule such powerful diuresis. In order to illustrate these statements I have selected the urograms of a fourteen-year-old girl with normal kidneys. A roentgenogram 15 minutes after injection of 25 grams of uroselectan shows the kidney drainage system

Fig. 6. Same case as shown in Figures 4 and 5. Roentgenogram taken six hours after injection of uroselectan. Note residue in pyelectatic kidney. This residue disappeared after 24 hours.

distended with densely opaque urine. One would almost term the minor calices slightly clubbed; the left ureter shows a peculiar loop; the bladder is well distended. A second roentgenogram taken 45 minutes later shows definitely less distention of the kidney drainage systems. The whole appearance of the pyelograms is now one of greater delicacy and especially the cupping of the minor calices is fine. The loop in the left ureter has disappeared—it was evidently due to the pressure of the fluid distending the kidney to capacity. In other normal cases, too, I have noted a serpentine appearance of the ureters comparable to the action of a garden hose when a strong force of water is suddenly turned on. The bladder is still filled. The third roentgenogram taken shortly after the second and immediately after emptying the bladder shows the pyelograms poorly outlined. The hydrostatic back pressure, as well as extrinsic pressure of the distended bladder on the ureters, has been released and the kidney drainage system may now empty itself; in fact, there may be a certain amount of suction to aid this. It must be appreciated that the films obtained by excretion urography represent not only anatomical structure but also action and motion, secretory and peristaltic. They are dynamic and not static: in that lies their interest and fascination, but also their shortcomings in diagnosis of anatomic-pathologic conditions. Contraction of some parts, producing inadequate filling with contrast medium, makes for inadequate visualization. The same inadequate visualization may happen when some part of the kidney drainage system fails to fill on account of disease of the kidney parenchyma—tuberculosis, for

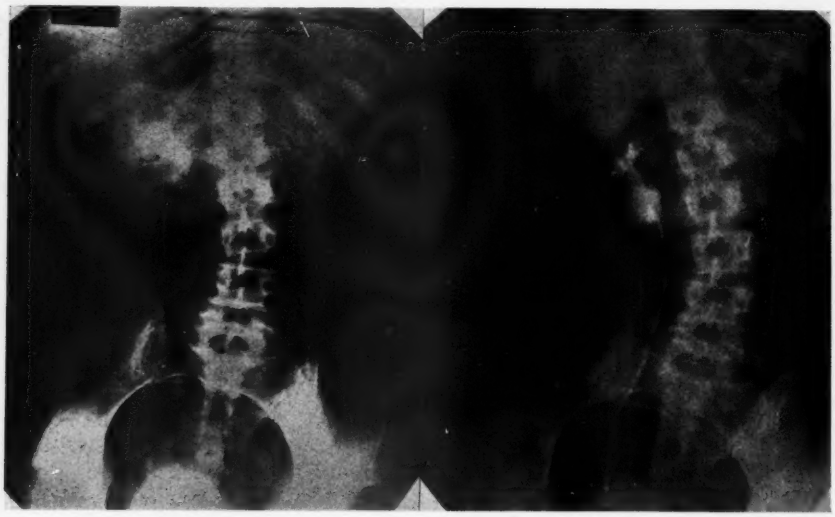


Fig. 7. Female, aged 49 years. Roentgenogram taken 30 minutes after intravenous injection of 40 grams of uroselectan. Advanced tuberculosis of left kidney, practically functionless. Right kidney normal. Contracted irritable bladder, cystitis. In six hours 42.5 per cent, or 17 grams, of uroselectan was excreted, evidently all by the right kidney.

Fig. 8. Retrograde pyelogram of the right kidney. Note that with this method, too, contraction of calices may prevent filling. Compare with Figure 7.

example. Braasch is absolutely right, therefore, when he states that the method may be unreliable as compared to retrograde pyelography in the diagnosis of the early changes caused by kidney tuberculosis or neoplasm. Improvements in technic will come, however, and the apparent defects of excretion urography may become valuable diagnostic points.

Allusion has been made already to the fact that, where the bladder is fully distended and the flow of urine from the kidney drainage system into it is impeded, the distention of the drainage system is greater, and, in consequence, more complete pyelograms are obtainable. To reduce the desire on part of the patient to empty the bladder I have found large doses of sodium bromide useful, enough to produce distinct somnolence. If the bladder is highly irritable, an opiate may be necessary. We may thus disturb the functional dynamic picture, but we gain back this loss in a truer anatomic image. Aside from the use of drugs, external compression of the lower ureters is of importance.

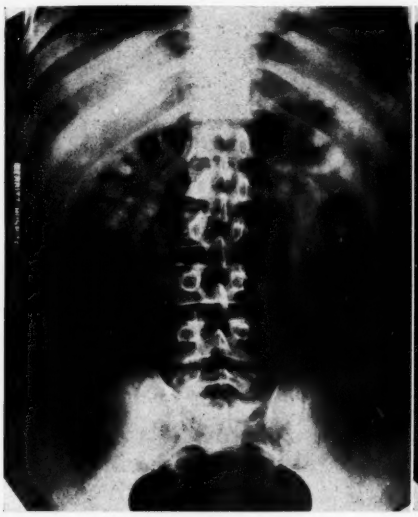


Fig. 9. Male, aged 36 years. Roentgenogram taken 10 minutes after intravenous injection of 40 grams of uroselectan. Bilateral kidney tuberculosis, advanced stage.

Fig. 10. Same case as shown in Figure 9, four hours after injection of uroselectan. Filling and density of the pyelogram are particularly good. In six hours this patient excreted 1,600 c.c. of urine and 23.68 grams of uroselectan, *i.e.*, 58.5 per cent, an almost unbelievable function in the presence of such extensive pathology.

Increasing the diuresis would also be an act of technical value. It is better to have the pelves and calices well distended with a lower concentration of contrast medium in the urine than to have a denser, but only incompletely outlined, pyelogram. The dilution of the drug as is practised by the writer is, therefore, an advantage in more than one way, and it also facilitates rapidity of injection. Drugs such as pituitrin might also be utilized to increase diuresis.

The excretion of the bulk of uroselectan in normal kidneys is completed in six hours and roentgenologically opaque urine may then be found only in the bladder. The drug,

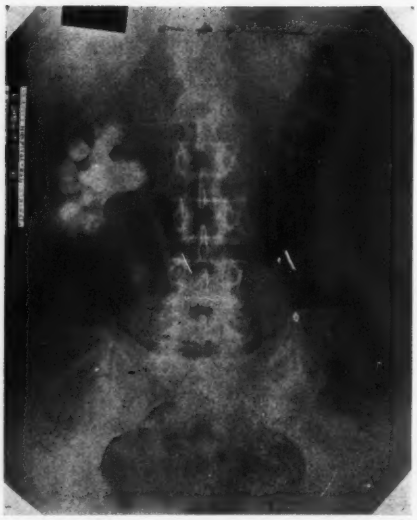


Fig. 11. Female, aged 65 years. Roentgenogram taken 15 minutes after intravenous injection of 20 grams of skiodan. The right kidney contains a huge, staghorn stone and excretes practically none of the contrast medium. The left kidney and ureter are beautifully demonstrated and are normal.

incidentally, may be recovered as such from the urine by rather simple chemical procedures, and we have done this repeatedly.

The most brilliant pyelograms—rather, urograms—are obtained in cases in which there is an obstruction by stone or stenosis of the ureter. Reproductions of several such films are shown. It is surprising how capable of excretion the kidney parenchyma remains in the presence of marked pyelectasis. In a case of double kidney tuberculosis, in which all semblance of normal pyelograms has been lost, there is still enough functioning parenchyma to bring out quite densely and distinctly a multitude of cavities. In a second case of unilateral tuberculosis there is no pyelogram visible on the left side at any time: the kidney has ceased to function.

A brief discussion of the value of excretion urography to clinical urology may be made in this paper. Von Lichtenberg, Swick, Braasch and others have already given us an evaluation in an authoritative manner. There is no question but that this new method of investigating the urinary system will give us information along the lines of physiology and pathologic physiology such as never has been obtained so graphically before. Furthermore, its simplicity and ease and safety, as far as the patient is concerned, will make it a favorite for a preliminary investigation of the urinary system—one might call it a "scouting expedition." The finer anatomic points may then have to be determined or at least confirmed by retrograde urography, which latter, as a moment's thought will show, can never be entirely replaced by excretion urography.

Abrodil-skiodan is chemically iodomethylsodium-sulphite ($N_aICH_2SO_3$) and has recently been introduced as a medium for intravenous urography by Bronner, Hecht, and Schüller, of Cologne and Eberfeld, Germany, in a paper published in *Die Fortschritte auf dem Gebiet der Röntgenstrahlen,* in August, 1930.

Under the name of "skiodan" this drug is distributed in the United States and, while not yet commercially available, the writer has been able to obtain three packages for experimentation. It is a white crystalline powder, readily soluble in water, making an absolutely colorless solution. The dose of this drug is considerably lower than of any of the other urographic media, it being only 20 grams for the average adult. Its iodine content is 52 per cent as contrasted to that of uroselectan, 42 per cent. Skiodan is an extremely stable compound chemically. It is isotonic at 4 per cent, which our own determinations corroborate exactly. Animal experiments show that it is tolerated in larger doses than uroselectan without ill effect. The investigators named above have injected doses of various magnitudes and determined its maximum concentration in the kidney urine. It ran quite constantly at 2.5 per cent iodine, *i.e.,* twice that figure in the substance itself. The greater doses, accordingly, do

not increase the density of the pyelograms, but the shadows are obtained over a longer period of time. I am nearly convinced that the same holds good for uroselectan and no marked advantage is obtained by increasing the dose to 60 grams, as has recently been suggested.

I have tried skiodan in two cases clinically, and may say that it is in all respects as safe and satisfactory as uroselectan, and its higher iodine content promises better pyelographic shadows.

The writer wishes to express his gratitude to Mr. George Giragosintz, without whose help the preparation of this paper would have lost much of its interest; also to Dr. George G. Reinle and Dr. William A. Clark, of Oakland, California, for supplying the clinical material as well as valuable suggestions and criticism.

Fig. 12. Female, aged 39 years. Roentgenogram taken 15 minutes after intravenous injection of 20 grams of skiodan. Note calculi in right kidney and pyelectatic cavities. Note normal pyelogram of left kidney and particularly the left ureter, which is seen in its entire course, including its entrance into the bladder.

Fig. 13. Same case as shown in Figure 12. Roentgenograms taken one hour after injection of skiodan. The pyelograms are better shown and denser than in Figure 12.

BIBLIOGRAPHY

ROSENO, A.: Studien zur intravenösen Pyelographie. Verhandl. d. deutsch. Gesellsch f. Urologie, 1928, VIII, 431.

Idem: Die intravenöse Pyelographie. Verhandl. d. deutsch. Röntgen-Gesellsch., September, 1929, XX, 73-75.

ROSENO, A., and JEPKENS, H.: Die intravenöse Pyelographie. Fortschr. a. d. Geb. d. Röntgenstrahlen, May, 1929, XXXIX, 859-863.

ROSENO, A.: Die intravenöse Pyelographie. Klin. Wchnschr., June 18, 1929, VIII, 1165-1170.

SWICK, M.: Darstellung der Niere und Harnwege im Röntgenbild durch intravenöse Einbringung eines neuen Kontraststoffes, des Uroselectans. Klin. Wchnschr., Nov. 5, 1929, VIII, 2087-2089.

VON LICHTENBERG, A., and SWICK, M.: Klinische Prüfung des Uroselectans. Klin. Wchnschr., Nov. 5, 1929, VIII, 2089-2091.

SWICK, M.: Intravenous Urography by Means of the Sodium Salt of 5-iodo-2-pyridon-N-acetic Acid. Jour. Am. Med. Assn., Nov. 8, 1930, XCV, 1403-1409.

Idem: Intravenous Urography by Means of Uroselectan. Am. Jour. Surg., February, 1930, VIII, 405-414.

BRONNER, H., HECHT, G., and SCHÜLLER, J.: Ausscheidungs-Pyelographie mit Abrodil. Fort-

schr. a. d. Geb. d. Röntgenstr., August, 1930, XLII, 206-218.
JACHES, L.: Intravenous Urography (Swick Method). Jour. Am. Med. Assn., Nov. 8, 1930, XCV, 1409-1412.
VON LICHTENBERG, A., and others. Kongressheft Fortschr. a. d. Geb. der Röntgenstr., XLII.
LUBASH, S.: Intravenous Urography: Better Visualization with Compression. Am. Jour. Surg., June, 1930, VIII, 1229-1232.
BRAASCH, WILLIAM F.: Intravenous Urography. Editorial, Surg., Gynec. and Obst., September, 1930, LI, 421.
HYMAN, A.: Intravenous Urography in Diagnosis of Urological Diseases in Childhood. Surg., Gynec. and Obst., September, 1930, LI, 409-415.
KRETSCHMER, H. L.: Intravenous Urography. Surg., Gynec. and Obst., September, 1930, LI, 404-408.
VON LICHTENBERG, A.: Intravenous Pyelography. RADIOLOGY, December, 1930, XV, 664-669.

DISCUSSION

DR. DAVID S. BEILIN (Chicago): I wish to sound a warning in the matter of the interpretation of roentgenograms of the genito-urinary tract by the intravenous method. It is necessary that we become thoroughly familiar with the physiology of the genito-urinary tract, and its manifestations resulting from perversion of function, intrinsically or extrinsically. A prominent urologist has informed me that he knows of two instances of nephrectomy in individuals who had normal kidneys, because of the fact that the roentgenograms taken at one and three hours after intravenous injections showed no pyelogram on the questionable side.

There are extrinsic conditions in the abdomen as well as infectious conditions in the genito-urinary tract, which may excite spasm in the pelvis and ureter, and result in the failure of a good pyelogram. Very early in our work with this method, in one case, the 15-minute film showed no pyelogram on the suspected side, whereas the opposite side revealed a good pyelogram. A roentgenogram taken at one hour showed no pyelogram on the suspected side, and a normal pyelogram on the opposite side; a roentgenogram taken at three hours showed a good pyelogram on the suspicious side. The clinician made the statement, after seeing the roentgenograms taken at 15 minutes and one hour, that in all probability there was a failure of secretory function on the suspected side, and probably a nephrectomy would have to be done. The three-hour film, with the pyelogram, revealed a calculus in the pelvis of the kidney, as well as hydronephrosis. At operation a pyonephrosis was found. The stone was removed, the pelvis of the kidney was drained, and the patient made an uneventful recovery.

I feel that before we can rely conclusively on the interpretation of this diagnostic procedure, we should allow some lapse of time in order to carefully check our findings. In non-conclusive cases, one should always resort to retrograde pyelography as a check on the intravenous findings. We have found that uroselectan is not irritating to the kidney, and have used it as an opaque medium in the retrograde examinations, discarding sodium iodide.

DR. SIEFERT (closing): I am sorry that in presenting my paper I had to omit, because of the time limit, the important points which Dr. Beilin's discussion brings up. To me, the caution which he recommends in the interpretation of the results obtained by the excretion method of urography, has been a matter which is taken for granted, and concerning which there is no argument.

It has been our observation that kidney function as expressed by excretion of the contrast medium under discussion runs by no means parallel with some of the functional tests employed by urologists in their work. For instance, excellent excretion urograms, and especially pyelograms, may be obtained showing good kidney function as regards excretion of the medium injected, and yet the indigo-carmine test will show definitely impaired function as regards the excretion of this dye. Conversely, too, we have observed in one case in which one kidney did not apparently excrete any uroselectan, that on the following day this same kidney showed normal function by the indigo-carmine test. These observations would indicate the necessity of caution, but also stimulate one's interest in the diverse excretory functions of the kidney parenchyma.

For emphasis, however, let me repeat that

Dr. Beilin's discussion and his recommendations should be heeded by everyone who is interested in excretion urography and its future development, and no one should be guilty of such unwarranted jumping at conclusions, and, worse still, the basing of irrevocable action upon them, as such, concerning which Dr. Beilin cites instances.

HIGH SPEED PARTICLES MADE BY NEW METHOD

WASHINGTON.—A new method of producing million volt ions, of the same immense speeds as found in radium alpha-rays, has been devised by Dr. E. O. Lawrence and Dr. M. S. Livingston at the University of California, and announced by them to the meeting of the American Physical Society, in May, 1931.

The high speed hydrogen particles are produced without the use of high voltages such as have previously been necessary in making artificial radium radiations. An ingenious method of multiplying the voltage has produced 80,000-volt hydrogen molecule ions in these experiments although only 2,000-volt oscillations were employed.

The charged hydrogen atoms spiral around inside two hollow semicircular plates in a vacuum. Great magnets placed outside the plates cause the particles to follow the curved paths, and the particles resonate in tune with the oscillations of the applied voltage.

Each time the particles pass from the interior of one plate to that of the other they gain energy by the same constant amount determined by the voltage applied. At each revolution, then, the speed is increased.

Dr. Lawrence stated that there are no difficulties in the way of producing 1,000,000-volt particles in this manner. A larger magnet is at present under construction at the University of California for this purpose.

—*Science Service.*

AN EXTENSION OF X-RAY RESEARCHES ON THE FINE STRUCTURES OF COLLOIDS TO NORMAL AND PATHOLOGICAL HUMAN TISSUES[1]

By GEORGE L. CLARK, PH.D., C. S. BUCHER, M.D., and OTTO LORENZ, M.S.,
Department of Chemistry, University of Illinois, URBANA

A FEW years ago Sir William Bragg outlined clearly five fundamental points in respect to which knowledge of the colloids is to be desired—such knowledge as X-ray diffraction analysis may be expected to contribute: (1) The internal structure of the colloidal particle; (2) the nature of the exterior layers; (3) the average size and distribution around the average; (4) the general shape or form of the particles, and (5) tendencies to orient. Speaking of cellulose, one of Nature's great colloids, concerning which some information had already been obtained, this great pioneer in X-ray science said, "The time will surely come when we shall know the place taken by each atom in the pattern."

As now, in 1930, we survey the field, we marvel at the accuracy of this prophecy. We are amazed at the progress which has been made by bringing together in research the X-ray method and colloids, with rapidly improving technic and with deepening knowledge of interpretation. In fulfillment of the prophecy concerning cellulose we find before us a table of the exact co-ordinates in space of every carbon and oxygen atom in cellulose and a complete structural model, including the size, shape, structure, binding, and orientation of the colloidal micelle, which must be correct in its essential details because it depicts so perfectly all the observable properties of textile fibers. Rayon has been very greatly improved in its properties by an X-ray study of the effect on structure of every detail in the manufacturing process from the raw material to the dyed fabric. The actual age of a growing cotton fiber can now be ascertained, and cotton classified as to quality by the X-ray pattern alone. Some of the most difficult problems concerning growth structure and technical uses of wood have been already successfully attacked, though researches have hardly begun. The structure, fundamental properties, colloidal particle size, and classification of natural silk and wool, both proteins, pectin, gelatin, collagen, body tissues, plastic films of cellulose acetate and nitrate used for photographic films or of cellophane, soap solutions, resins, linseed oil films (paint, patent leather) and many other substances classed as colloidal, besides the familiar sols of metals or salts, have been subjected to X-ray study with most interesting and promising results in spite of the complexity of constitution in many instances. Before a summary of some of these developments is made, it is advisable to review briefly the fundamental principles of colloid classification and of X-ray diffraction by colloidal materials.

1. X-ray Diffraction by Crystalline and Amorphous Substances.—It is, of course, now widely known that crystals act as three dimensional diffraction gratings for X-rays by virtue of the arrangement of the lattice units (atoms, ions, molecules or groups of these) on sets of equidistant parallel planes. With a beam of monochromatic rays passing through a specimen, a pattern on a photographic plate is obtained, absolutely characteristic of the material as to whether it is crystalline or amorphous, what its crystallographic system and space group defining co-ordinates in space, and the interplanar spacings are—whether it is a single crystal

[1]Presented before the Radiological Society of North America, at the Sixteenth Annual Meeting, at Los Angeles, Dec. 1–5, 1930.

or an aggregate, whether the aggregate has random or preferred orientation of grains, whether it is a single pure substance or is a mixture of two or more individuals or a solid solution, how large the grains or particles are or how thick a film, and whether there is distortion or strain. It follows that an amorphous substance would merely scatter X-rays in all directions and produce a general fogging of the photographic plate without evidence of diffraction interference maxima, whereas any kind of arrangement of ultimate units, even though very imperfect, would produce a diffraction pattern characterized by interference maxima. Even a single diffuse broad diffraction ring indicates at least an elementary tendency towards organization. One of the most remarkable facts from X-ray science is the extreme rarity of the true amorphous state. Repeatedly it has been found that a specimen which by all ordinary methods of examination appears to be amorphous, produces unmistakable evidence of an organized ultimate structure under the searching scrutiny of radiation with wave lengths only 1/10,000th as long as ordinary light, by means of which microscopic examination is made. Even liquids produce diffraction haloes indicative of transient arrangement of molecules governed by distances of nearest approach in their thermal agitation, and designated by Stewart as "cybotaxis," while just now results on diffraction haloes from gases have given evidence of the true structure of atoms in the sense of the distribution of diffuse wave-like negative electricity, according to Heisenberg and Compton, instead of sharply corpuscular electrons moving in orbits as depicted by the Bohr theory.

2. *Diffraction by Colloids.*—A single crystal subjected to analysis by the pinhole method produces a Laue diffraction pattern characterized by a symmetrical array of spots, lying on a series of ellipses. As the size decreases and more individuals lie in the path of the beam, this symmetrical pattern gives way to a random "peppering" of spots. As the size decreases and the number increases still further, these small spots begin to assemble on a series of concentric rings. Finally the spots become so small and numerous that they merge into uniformly intense concentric rings, the so-called "powder" pattern. The maximum range of grain diameter over which these sharp rings are registered is from 10^{-3} to 10^{-5} centimeters. It is clearly evident that a sharp interference effect can take place only with a certain minimum number of parallel diffracting planes in each particle. As this number falls below the minimum, or, in other words, as the particle size decreases below about 10^{-5} cm., it follows that interference is less perfect and that the diffraction rings (or lines by the Hull-Debye-Scherrer method) will become broader in proportion to decreasing size until in the neighborhood of 10^{-8} cm. atomic dimensions are reached. These will merge and the pattern will be classed as amorphous. A measurement of line-breadth in the colloidal range will, therefore, enable calculation of particle size as will be illustrated later. The question arises as to how small a particle can be and still produce a diffraction pattern upon which maxima may be detected. Levi, in his study of metallic catalysts, reports that particles only about five times as large as the unit crystal cell (in other words, 10 or 15 parallel planes) will produce resolved diffraction maxima even though these are very diffuse.

Now it must be noted that diffuse diffraction maxima must be the consequence of any crystal grating which is imperfect in the sense of having too few parallel planes, or of having these planes, ordinarily sufficient in number, distorted, bent, or imperfectly aligned. In other words, it is conceivable that an assemblage of fairly large colloidal particles might yield very diffuse patterns

Fig. 1. Normal bone.

simply because molecules, which may themselves be very large, are not oriented in regular fashion. This condition is observed in the colloidal gels and is particularly interesting in the light of the prediction that simple mechanical stretching might tend to pull these diffracting units into parallel position and thus act as a diffraction grating.

The question which naturally arises next is whether there is a continuous transition between the crystalline and amorphous states. From what has been said concerning continuous broadening of lines till these merge and spread over the entire film, such a process would be indicated. Sir William Bragg quotes the experiment by the present writer on carbon. An activated charcoal producing an essential amorphous pattern had certain characteristic chemical and physical properties which changed over to those of graphite upon brief heating at 1100° C. The X-ray pattern, however, was unchanged, since no lines appeared. The great activity of the original charcoal was ascribed to the free valences of disorganized carbon atoms. Upon heating, the solid phase being retained throughout, these began to mutually attach themselves to satisfy these bonds and to form crystal planes of graphite, which were still too few and bent to permit interference of rays, though the properties were typical of graphite. This stage of elementary organization was designated "paracrystalline." Upon further heating, the grains grew in size, and the planes in number and rigidity, so that broad diffraction lines for colloidal dimensions finally sharpened to the typical graphite spectrum.

Another state of affairs, however, is observed with those substances so masterfully studied by Friedel, which display mesomorphic states of matter or liquid crystal phases. Here there are sharp discontinuities between the liquid or so-called amorphous phase (though this yields liquid rings), the nematic (in which the long molecules point in one direction but are not constrained in parallel planes, hence produce no crystal patterns), the smectic (in which the molecules are arranged in parallel planes in one direction, thus giving a crystal interference for one dimension only), and finally the crystalline, in which the molecules take up regular marshalling in three dimensions. Undoubtedly, then, transition phenomena must occur in all cases of solidification of a molten substance, but only in the case of certain long organic molecules is the temperature range of each state sufficiently extended to permit detection and examination.

3. Grain Size Measurement in the Colloidal Range.—The measurement of particle size, particularly in the range 10^{-5} to 10^{-8} cm., is now a well-established application of diffraction information. In the colloidal range, the smaller the particle and the fewer the diffracting parallel planes, the less perfect is the sharply unidirectional interference of secondary waves, and the broader will be the diffraction maxima which characterize a given crystalline structure. Hence a measurement of the breadths of diffraction lines or spots at points of half-maximum in-

tensity leads to an evaluation of grain size in an aggregate or colloidal dispersoid.

Debye and Scherrer were the first to derive an equation connecting particle size with an experimental measurement of the breadth of interferences at points of half maximum intensities. The equation is

$$B_{\text{Scherrer}} = \frac{2\sqrt{\ln 2}}{\pi} \cdot \frac{\lambda}{D} \cdot \frac{1}{\cos \theta/2} + b$$

where B is the breadth of a diffraction interference at points of half maximum intensity, λ is the wave length, D is the edge-length of the crystal considered as a cube, θ is the angle of diffraction, and b is the natural minimum breadth of the Debye-Scherrer diffraction line which is a constant depending upon the particular apparatus and size and absorption of the specimen. Scherrer first determined b by plotting measured values of B against $1/\cos \theta/2$ for a sample of colloidal gold. The straight line drawn through the points was then extrapolated to cut the ordinate axis which was the value of $b_0 = b_r$ where r is the radius of the camera. This equation served for several years, though comparatively little work was done on critical experimental test. Selyakov, by a considerably more straightforward proof, derived the equation

$$B_{\text{Selyakov}} = \frac{2\sqrt{3 \ln 2}}{\pi} \cdot \frac{\lambda}{D} \cdot \frac{1}{\cos\theta/2} + b$$

which differs from the Scherrer equation by less than 2 per cent. W. L. Bragg, by remarkably simple reasoning and calculation, utilizing the conception simply of n planes of thickness d arrived at the equation

$$B_{\text{Bragg}} = 0.89 \frac{\lambda}{D} \cdot \frac{1}{\cos \theta/2} + b.$$

Expressed in the same form,

$$B_{\text{Scherrer}} = 0.94 \frac{\lambda}{D} \cdot \frac{1}{\cos \theta/2} + b.$$

In 1926 von Laue (1) deduced from vector analysis a new equation which in its most general form is free from the limitations of the cubic system, and permits size evaluation in different directions and thus *shape* of a particle. In the simplest rigorous form this equation is

$$B_{\text{Laue}} = \frac{\frac{\pi}{2} \frac{\omega}{\eta} \left(\frac{r}{R} \cos^2 \frac{\theta h}{2} \right)^2}{\sqrt{1 + \left(\frac{\omega r}{\eta R} \cos^2 \frac{\theta h}{2} \right) - 1}}$$

where

$$\omega = \frac{1}{1.8} 0.55; \quad \eta = \frac{\omega}{2\pi} (B \cos \theta/2 - 1/B) \left(\pi \frac{r}{R} \right)^2 \cos^3 \theta/2;$$

r = radius of the cylindrical specimen, R = radius of camera, and θ = reflection angle. A simplified expression used with singular success by Hengstenberg and Mark (2) in determining the actual size and shape of the colloidal micelles of rubber and cellulose is $R\eta = 0.088 [(b \cos\theta/2 - (1/b)\pi^2 r^2 \cos^3\theta/2)]$ where $R\eta$ and θ have the same significance, $b = BR$ is the actually measured breadth of the interferences, and $\eta = \lambda/4\pi m a_i$; where ma_i is the extension of the crystal particle in the direction a_i, or the magnitude which is to be calculated with all other numbers known or experimentally measurable.

The Laue derivation has been subjected to critical examination and extension lately by Patterson (3), Brill (4), and the writer. The necessary conditions for the Laue equation are for absorption in the crystal powder, which is negligibly small, for completely random orientation, for particles of the same form and size, for undistorted lattices, and for known crystal structures. Patterson extended the theory to the case in which the particles have different sizes, and he showed that the sizes must have a Maxwellian distribution. Without information concerning the distribution function the average particle size cannot be determined. Brill extended the theory to the case of substances opaque to X-rays and derived corrections for absorption, and for the overlapping of the α-doublet interferences. The writer has

extended these calculations and derived the following general and rigorous formula for ma_i, the extension (or size) of the crystal particle in the direction a_i:

$ma_i =$

$$\left[\frac{3.6\lambda\sin^5\theta/2\tan\theta/2RB}{4d(B+\pi r\sin\theta\sin\theta/2)\,(B-\pi r\sin\theta\sin\theta/2)}\right]$$

where $B = b - \delta/3$ (b = measured width of interferences at points of half-maximum intensity), δ = separation of the α-doublet, d = lattice constant from known crystal structure, and the other symbols have the same significance as noted before.

The latest and most ingenious advance in particle size measurement has been made by Brill and Pelzer (5). The previous methods have all been subject to uncertainties concerning the relation between blackening of the photographic film and the intensity of incident X-rays, and the determination of positions of half-maximum intensity of diffraction interferences by means of the photometer. If the specimen under examination is in the form of a hollow cylinder (and thus is transparent to X-rays and obeys the Laue equations), then over a certain range of particle sizes each interference will be split into two maxima, the separation of which is a measure of particle size. Instead of measuring breadth at points of half-maximum intensity, the much more direct measurement of the distance between two lines is involved. For such a case the particle size (for the cubic system) must have a value

$$D > \frac{R\lambda\sqrt{2}\,.\,1.8}{4\pi\, r\cos^2\theta/2}.$$

For both large particles yielding sharp interferences, and for very small particles for which these two maxima become broad and overlap, single lines are observed. The simpler equations derived for the particle size involved in the split lines are as follows:

(Small) $\eta =$

$$\frac{\cos\theta/2}{1.8.\sqrt{2}}\sqrt{\left(\frac{r}{R}\cos\frac{\theta}{2}\right)^2-\frac{7}{80}\left(\frac{e}{R}\right)^2}$$

(Large) $\eta =$

$$\frac{1}{1.8}\,\frac{1}{2}\sqrt{3}\,\frac{r}{R}\left[\cos^2\frac{\theta}{2}-\left(\frac{e}{4r}\right)\right]$$

where e is the linear separation of the two maxima, and $\eta = \lambda/4\pi D$ for cubic crystals, or more generally

$$\eta = \frac{\lambda}{4\pi}\sqrt{\Sigma\left(\frac{b_iG}{m_i}\right)^2};\quad G=\frac{\Sigma h_ib_i}{|\Sigma h_ib_i|},$$

where h_i are the crystallographic indices of any particular lattice plane, m_i the edge length in the direction i, and b_i the ground vectors of the reciprocal lattice.

The equation for the case of very small particles for which the pairs of lines fuse is

$$\eta = \omega\cos\frac{\theta}{2}\sqrt{\left(\frac{B^1}{2\pi}\right)^2-\left(\frac{r}{R}\cos\frac{\theta}{2}\right)^2}$$

where $B^1 = \dfrac{2B}{\cos\dfrac{\theta}{2}}$ and B the breadth of half-maximum intensity. Rigorous comparative tests have been made for the new equations derived for hollow cylindrical specimens with complete agreement for magnesium oxide (Brill and Pelzer), and even for preparations for colloidal gold, silver, and carbon (Clark and Zimmer).

4. Direct Measurement of Colloidal Particle Sizes.—The foregoing methods of particle size measurement obviously involve assumptions, and independent methods of evaluation are necessary for their test. The best possible method would, of course, depend upon actual diffraction interference, corresponding not to the small unit crystalline cells but to the length and cross-section of colloidal particles, for each of which d may be calculated by the simple Bragg equation. This necessitates a regular arrangement and uniform size of these colloidal particles with respect to each other, so that specimens are limited to organic micellar

systems consisting of small elongated particles regularly oriented in a fiber such as in natural cellulose and in stretched rubber. Another difficulty, of course, is that the diffraction interferences corresponding to colloidal dimensions of one or two hundred Å.U. will appear at such small angles that resolution from the primary undiffracted beam will be extremely difficult or impossible. There are two experimental possibilities: define the beam by extremely fine pinholes or slits or utilize X-radiation with a wave length much greater than that usually employed (molybdenum Kα doublet 0.71 Å.U.; copper 1.54 Å.U.). By the first method with copper radiation Mark (6) was able to distinguish a broad interference spot very near the primary beam for bamboo and wood cellulose corresponding to a spacing between 50 and 100 Å.U. and evidently due to reflection from the surfaces of particles of this breadth. Clark and Corrigan (7) have utilized the second method, with interesting preliminary results. A combined X-ray tube, pinhole system, and camera was constructed with the target of the tube magnesium (Kα wave length 9.86 Å.U.). On account of great absorption of radiation, the entire apparatus was operated at the X-ray tube vacuum, and extremely thin specimens of rubber and cellulose employed. Upon the films appeared a ring for unstretched rubber corresponding to 99.3 Å.U. and for cellulose fibers the spacings 85.0 (evidently corresponding to Mark's value for breadth) 274.1, 168.0, and 156.0 Å.U. The micellar sizes deduced from measurement of interference breadths and calculation by the Laue equation are approximately 50×600 Å.U. for cellulose and $150 \times 500 \times > 600$ Å.U. for stretched rubber. Further researches by this important direct diffraction method will permit a careful comparison of values and establish the validity of the equations deduced from theoretical considerations which may then, in turn, be used with confidence for those colloidal substances in which there is no organized micellar structure.

Fig. 2. Tendon (unstretched).

5. Results on Colloidal Metals and Inorganic Compounds.—Numerous references are to be found in the literature to experimental measurement of particle size for colloids as well as identification of crystallographic system. It is convenient to determine these properties as functions of various methods of preparation of industrial materials. Citation of only a few examples must suffice here.

1. First of all, the identification of the colloidal state *vs.* molecular or super-colloid state (not limited to solutions as is the Tyndall cone).

2. Relation in grain size and structure in extremely thin electrodeposited films and colloidal sols such as those prepared by the Bredig arc method.

3. Catalytic activity, as for nickel hydrogenation and dehydrogenation catalysts, as a function of lattice structure and grain size (work in the writer's laboratory indicating an optimum rather than minimum grain size associated with greatest activity).

Fig. 3. Tendon (stretched).

4. Structure and grain size of colloidal lead (8) as a function of therapeutic value when injected into tissues subsequently irradiated.

5. Structure and grain size as functions of spreading, wetting, obscuring power, stability, gloss, etc., and of mode of preparation in pigments (zinc, lead, tin, aluminum and other oxides).

6. The discovery of the presence of colloidal crystallites in glass, entirely apart from coloring agents added (9).

7. Grain size measurements in tungsten and other metals where grain boundaries are not satisfactorily developed for microscopic counting even for large grains.

8. Studies of possible allotropic forms of colloids produced at various conditions of pH (in all ranges the sphalerite lattice and not the wurtzite is found for colloidal zinc sulphide, contrary to various contentions).

9. Numerous cases of identification of colloidally dispersed phases in natural and artificial minerals, alloys, including martensite and troostite, etc., uniformly mixed or at grain boundaries; clear differentiation between solid solution and physical mixtures.

10. Test for presence of invisible colloidal particles, such as brass or copper in parchment; completeness of filtration and dialysis.

11. Grain size and uniformity (particularly barium) in metal mirrors, in radio tubes, photo-electric cells, etc.

12. Identification of adsorbent films and chemical changes (for example, mercuric chloride solution adsorbed on charcoal gives the crystal diffraction pattern for colloidal mercurous chloride).

13. Studies of the phenomena involved in dyeing of textiles utilizing metallic sols adsorbed on fibers (sometimes fibered layer, sometimes random).

14. Estimation of crystallinity, dispersion, and grain size of excess sulphur in vulcanized rubber.

15. Amorphous carbon, coal, and resins.

Recently a series of papers have appeared from the laboratory of Sir C. V. Raman, which have advanced to a remarkable degree the knowledge of the structure of materials usually classed simply as amorphous. This has been made possible by the observation of an entirely new phenomenon appearing at small angles to the primary beam in the diffraction patterns of all varieties of amorphous carbon, namely, a strong scattering extending to about 7°. This corona was first observed in solutions of cane sugar and was definitely attributable to the molecules of the dissolved substance which are distributed at random in the solvent, in much the same way as gaseous molecules.

Krishnamurti (10) has found for samples of sugar, benzene, and naphthalene charcoals and carbon, obtained by charring ash-free gelatin with molten sodium, together with colloidal graphite prepared by exploding graphite acid in a vacuum, that all showed the small angle scattering in a marked manner. The patterns showed two rings in addition to the central scattering, the first and prominent ring corresponding to the

(002) reflection of graphite, having a spacing of about 3.8 Å.U. as compared to 3.4 Å.U. of graphite. The outer ring was fainter and broader and showed a spacing of 2.12 Å.U., comparable to the (111) spacing of graphite (2.06 Å.U.). The observations accord with the idea that in the amorphous state the carbon atoms join together in clusters, forming highly anisotropic units essentially two dimensional, the thickness being about one-third the length or breadth. Assuming that the central scattering is due to the dimensions in the plane of the particle, and the first ring to its thickness, a rough calculation gives about 60 atoms of carbon per unit. This picture of the carbon particle agrees with chemical evidence, mainly its oxidation to mellitic acid and adsorptive properties.

Mahadevan (11) has made an extensive X-ray study of the various varieties of coal, principally vitrain and durain. Vitrain, for example, gives two haloes in the position of the two most prominent graphite carbon rings. They are wide and diffuse, suggesting the colloidal nature of the diffracting particles. The haloes are due to the complex carbon molecule present in vitrain. The increase of moisture content seems to be accompanied by a finer division of the particles, as evidenced by broadening of the rings. The results on durain indicate that it belongs to a colloidal system of the suspensoid type, where vitrain acts as a dispersion medium and the ash and vegetable detritus (with free carbon as end product) as disperse phases. In a study of vitrains (12) of different geological ages, the intensity of the general scattering is seen in the case of the older coals to be approximately proportional to the sum of moisture content and volatile matter. In all cases the sizes of the diffracting particles are found to be of colloidal dimensions. The mineral matter in the ash is also present in a colloidal state. These and related investigations have opened up a whole new series of applications of the X-ray diffraction method by amorphous solids. There has been a further extension (13) to the case of natural and fossil resins and to the changes during heating of ordinary rosin, shellac, and synthetic resins. The importance of these studies can scarcely be overestimated on account of the much greater amount of information obtained on seemingly hopeless materials and on account of the possibility of solving many difficult problems, particularly in chemistry and geology.

6. The Nature of Colloidal Solutions as Revealed by X-ray Diffraction.—Following the discovery of Krishnamurti (14) that diffraction patterns of aqueous solutions of cane sugar, levulose, and glucose were distinguished by intense scattering at small angles due to the dissolved molecules, it was then possible to undertake the study of colloidal solutions for which the state of molecular aggregation has been the subject of much speculation. The molecular weight of dextrin calculated from the extent of "amorphous" scattering by means of the Bragg formula $\eta\lambda = 2d \sin \theta$ comes out 600, and for gelatin, 3,000, which are not improbable values. The solution of sodium oleate produced a ring due to the presence of large groups or micelles of sodium oleate in the solution. The extent of the gaseous scattering gave the dimension for the sodium oleate molecule, agreeing with that calculated from molecular weight and density. An excess of scattering directly adjoining the central spot is due to large groups of ionic micelles, described by McBain. Aqueous solutions of starch, tannic acid, and gum arabic showed a further scattering at small angles to the primary beam due to the dissolved molecules or micelles. The molecular weights calculated from the extents of the coronas were 6,200, 3,134, and 2,810, respectively. Thus, a starch molecule contains about 10 dextrin molecules united together, and a tannin micelle contains 10 sim-

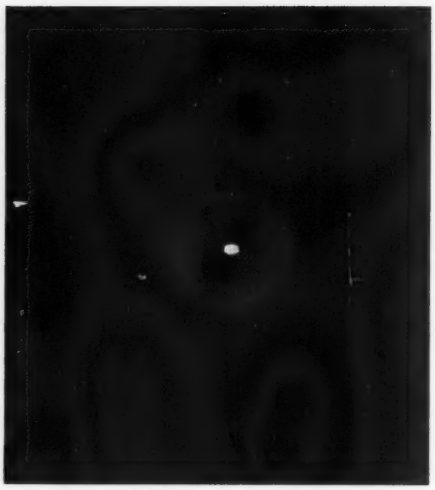


Fig. 4. Nose cartilage.

ple molecules of the formula $C_{14}H_{10}O_9$. The greater importance of these studies is at once apparent when it is considered that extremely valuable information should be obtained from biological fluids including blood, filterable virus, etc. In all these cases of amorphous solids, liquids, and solutions, the X-ray patterns are characteristic in showing the presence of one or more diffraction bands, even though these may be ill defined. The purely amorphous scattering where no maxima are present evidently can exist only in the case of ideal gases. All of these newer investigations are in agreement with the contention by the writers that such a material as amorphous carbon represents an intermediate state, designated as para crystalline, through which the atoms of carbon have to pass before obtaining the orderly arrangement underlying the graphite structure.

7. The Structure of Highly Polymerized Organic Substances Found in Nature.— Only a short time ago, very little could have been said upon this subject, not only from the X-ray diffraction point of view but even from that of chemical investigation. The appearance of a new book of more than 250 pages by Meyer and Mark (15), bearing the title of this section, is in itself sufficient evidence of the amazing progress in the study of some of the most familiar natural material. Impetus to these investigations was given to a large extent by the X-ray analysis of polymerized formaldehyde in the laboratory of Staudinger.

X-ray results on the colloidal polymerized natural products indicate clearly that a common structural plan is utilized for such widely different substances as cellulose, proteins of all kinds, chitin, rubber, gutta percha, balata, and chicle. Long primary valence chains or macromolecules are built up from a relatively simple molecular group (for example, dehydrated glucose residue in cellulose and isoprene in rubber). A bundle of these chains, which may be 500 Å. U. long, are held in position by secondary valence forces and constitute the colloidal micelle familiar in diffusion and molecular weight experiments. From usual diffraction patterns, however, very much smaller periodicities and simpler constitution are directly measured. The explanation is found in the fact that the long macromolecules are spiral in character, and one turn in the screw axis is sufficient for a diffraction periodicity, since all other turns are exactly the same. Within the unit crystal cell, therefore, only a small number of the molecules of the parent monomer are found, instead of one or more of the actual long macromolecules. The information obtainable from diffraction patterns of the crystalline part of these natural products is as follows:

(1) *Crystallographic system.*

(2) *Dimensions of the unit crystal cell and the number of monomeric molecules in each from a known density value.*

(3) *Co-ordinates of atoms within the unit cell which demonstrate molecular shape of simplest chemical unit, and the bonding*

of these, through primary valence bridges, into polymerized chains with small periodicities due to screw axis of symmetry. These chains are further indicated by optical anisotropy and by the remarkable persistence during all kinds of chemical treatment, such as oxidation, mercerization, xanthogenation, nitration, acetylation of cellulose, vulcanization of rubber, etc.

(4) *The length of the macromolecules, or, in other words, of the colloidal micelle, and of the cross-section which is determined by the number of chains in a bundle.* These magnitudes are ordinarily calculated from the breadths of the intensity maxima, as explained in a previous section. It has been possible, however, in the writers' laboratory to measure these large spacings from direct diffraction interferences when sufficiently long X-ray wave lengths are employed so that angles of diffraction will be, in turn, sufficiently large to permit resolution from the undiffracted X-ray beam.

(5) *The arrangement of the micelles within the substance, whether with a preferred orientation with respect to one direction as in a fiber or random.* In the latter case a pinhole diffraction pattern shows uniformly intense continuous concentric rings. As definite positions are taken up, intensity increases in certain places and decreases in others. Rings become arcs and then symmetrically arranged spots, as the orientation is increasingly more perfect.

(6) In terms of all the foregoing types of information, the effects of chemical change, swelling and mechanical deformation, such as tension, can be followed and, of course, observed properties rationally accounted for.

It is not possible in this paper to present in detail for this great class of colloids the X-ray data and the steps in interpretation, which have, it must be admitted, involved controversy, though not among X-ray workers.

Rather, these results will be briefly tabulated and particular attention paid to the practical consequences and predictions from structural models constructed from X-ray data.

CONSEQUENCES OF DEDUCTION OF STRUCTURES

1. Cellulose (16)

(a) Proof of identity of crystalline part of natural varieties of ramie, sisal jute,

TYPICAL X-RAY DATA FOR FOUR IMPORTANT POLYMERIZED ORGANIC NATURAL MATERIALS

Product	*Crystal system*	*Unit cell dimensions*		*No. molecules*	*Space group*	*Micelle dimensions*
Cellulose	Monoclinic	a	8.3	4 $C_6H_{10}O_5$	C_2^2	50 Å. U. cross
		b	10.22			600 Å. U. length
		c	7.9			
		β	84°			
Cellulose hydrate	Monoclinic	a	8.14	4 $C_6H_{10}O_5$	C_2^2	Doubtful—chains less parallel
		b	10.30			
		c	9.14			
(mercerized)		β	62°			
Rubber	Orthorhombic	a	12.3	8 C_5H_8	V_4	150 × 500× >600
		b	9.3			
(stretched)		c	8.1			
Silk fibroin	Monoclinic	a	9.68			
		b	7.00			
		c	8.80			
		β	75° 51′	4 Alanylglycyl		

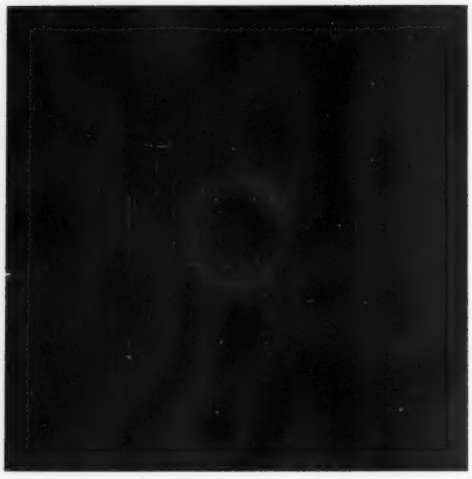


Fig. 5. Nerve.

hemp, flax, cotton, wood, tunicin (animal cellulose), B—Cellulose (bacterial) etc.

(b) Rational explanation of properties such as tensile strength, elasticity, etc., from arrangement of micelles. The more perfectly parallel to the fiber axis the greater the tensile strength.

(c) Differentiation of cellulose fibers in terms of micellar arrangement (parallel to fiber axis in ramie, spiral layers in cotton) and of other substances present.

(d) Surest method of identification of true cellulose, which involves *both* constitution and spacial co-ordinates: esterify unknown, dissolve in proper solvent, spin and regenerate fiber under tension to orient micelles, saponify in solid phase and examine diffraction pattern of fiber suspected to be cellulose.

(e) A remarkable improvement in the quality of rayon from the prediction that tension on plastic fiber during regeneration should pull micelles parallel (X-ray fiber pattern) and greatly increase tensile strength; a structural test of every step in the process to yield optimum structure and properties; assurance that the manufacturing process has not been so severe as to break primary valence chains in original raw material (wood pulp or cotton linters), as was the case before X-ray research with micellar lengths only half as great as in starting material.

(f) Improvements in cellophane manufacture to eliminate directional properties due to slight fibering in sheet when completely random arrangement is desirable.

(g) Classification of raw cotton from degree of fibering since ultimate structure is conditioned by growth environment; proof that ancient cottons had a superior fibrous structure not now existent in any cultivated variety.

(h) Study of growth of cotton daily from the root hair to mature 50-day fiber; diffraction patterns characterized by gradual increase in organization, decrease in lattice dimensions, and, hence, intramicellar swelling and the sudden appearance of fibering with wall thickening.

(i) Classification of kind of wood, angle of fibrils, differentiation of spring and summer wood, and of normal and compression wood (upper and lower side of bough).

(j) A method of proving whether swelling is reversible and inter- or intra-micellar; for example, wood and cotton swell when water penetrates between micelles. Other solutions penetrate between chains and produce change in lattice dimensions; new processes for impregnation of wood to avoid swelling and water penetration.

(k) A new process successfully predicted from cellulose model that cotton may be suitably swollen, maintaining solid form, stretched and greatly strengthened by virtue of improved orientation of micelles.

(l) A proof that only the triacetate and trinitrate form definite crystalline substances since esters of intermediate composition show X-ray interferences for unchanged cellulose and for the tri-ester only; for parts in which all of hydroxyl groups have

not reacted, the distortion of the lattice results in no observable sharp interferences. On this account none of the commercial nitrate or acetate films yield more than a very diffuse amorphous pattern so that variations in manufacturing steps cannot be followed. By plastic stretching of the films molecules are pulled more nearly into alignment but only a pseudo-crystalline pattern and structure is gained before breakage on account of the interference of amorphous material with completely parallel orientation.

(m) Discovery of the only method of obtaining native cellulose back from mercerized. Two trinitrates are found from X-ray patterns, both produced from either native or mercerized cellulose under controlled conditions. Upon denitration Trinitrate I yields native and Trinitrate II hydrated cellulose only.

(n) Identifications of various compounds such as Knecht's (with nitric acid), Normann's (copper-alkali-cellulose), copper-amino-cellulose; a rational explanation of observed chemical properties and reactions, oxidation splitting, etc.

(o) Conditioning of fiber structure to problems of dyeing, to various types of paper and a control of paper manufacture.

(p) The proof that celluloid is a double compound of nitrocellulose and camphor. In a remarkably convincing series of papers, Katz (17) and associates have utilized X-ray patterns correlated with optical anisotropy to show that with small camphor contents (to 10 per cent) unchanged long nitrocellulose micelles and long micelles of the camphor-nitrocellulose compound lie side by side. The first possess strongly positive birefringence with respect to the longest axis, the latter weakly negative. The changes in diffraction patterns clearly indicate such a reaction with camphor, other cyclic ketones, acid amides and esters, aldehydes and nitriles (all predicated and verified from the observation of —C = O combination with nitrocellulose chain) as swelling and gelatinizing agents.

2. *Rubber*

(a) Unique proof of micellar structure and parallel orientation of long-chain molecules of C_5H_8 when stretched.

(b) A fundamental mechanism of elasticity based upon the mutual effects of double bonds in the unsaturated hydrocarbon in coiling up spring-like molecules.

(c) A method of racking rubber 10,000 per cent or more, discovered in the course of X-ray work.

(d) Discovery that rubber after long standing at cool temperatures "freezes" and produces diffraction interferences for random crystal grains.

(e) A "melting curve" for natural rubber determined by von Susich (18) from X-ray patterns.

In frozen samples interferences disappear above 35° C., while with increasing degree of stretching the temperature at which crystalline patterns become amorphous, increases up to 90° for great elongation.

(f) The only exact method of distinguishing natural and synthetic rubbers so far produced and the criterion of successful synthesis in the future—another indication that the terms "rubber," "cellulose," etc., imply not only constitution but also spacial structure.

(g) Sharpening of interferences on vulcanization indicating sulphur bridge formation between chains though the unit crystal cell is the same; with increasing sulphur content, loss of elasticity as a result of *net* formation of molecules in hard rubber.

(h) Cooling of racked rubber with liquid air results in patterns with the appearance of Laue single crystal diagrams for metals, indicating larger organized lattice units than the usual micelle.

(i) Rational explanation of greater tensile strength of stretched samples with

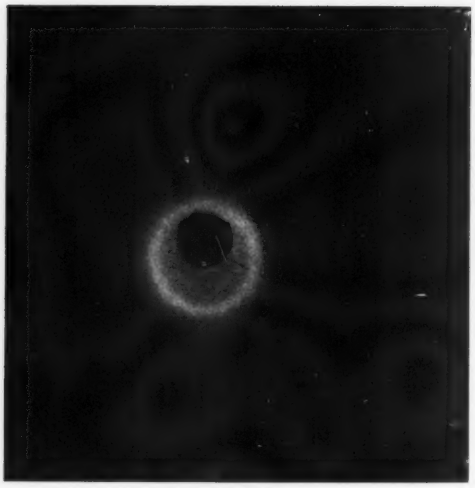


Fig. 6. Muscle of limb.

greater van der Waals' forces; *c.g.*, unstretched raw rubber (liquid air) 5.4 kg. mm.^{2}, stretched 35.1; vulcanized unstretched 5.3; stretched 44.4.

3. Gutta Percha, Balata, and Chicle

There has been a very considerable disagreement concerning the structures of gutta percha and balata, which are, like rubber, polymers of isoprene. The discrepancies have at last been explained in the work of Hopff and von Susich (19) and of Stillwell and Clark (20). These two substances produce diffraction patterns different from rubber but probably like each other. These are two modifications, the α which is stable below 60° C., and β, produced by heating above 60°, giving different patterns in the unstretched state. The β-modification also produces a fiber pattern, since the specimens must be warmed before stretching. Stillwell and Clark have found balata in ordinary commercial form to differ from ordinary gutta percha, in the same way that von Susich's α-modification differs from β-gutta percha.

Chicle has been studied by Stillwell and Clark; the hydrocarbon constituent here is identical with gutta percha. The resins, calcium oxalate and other substances constitute the remainder of this product.

Rubber, gutta percha, balata, and chicle all are built from hydrocarbon chains of the same constitution. The difference comes in a cis configuration for rubber, where the identity period is 8.2 Å.U., and a trans-form in the gutta percha, or zig-zag chains with an identity period of 9.2 Å.U.

4. Proteins

(a) Fibroin, one of the constituents of natural silk, shows a distinctly crystalline structure, the analysis of which is given in the tabulation. The chains of amino-acid residues are bound in peptide linkage to form long spiral macromolecules, with 4 alanylglycyl residues per unit cell. The micelles are embedded in a matrix and are perhaps here and there chemically bound together. The amorphous part of the silk consists of irregular chains which may even be bound into micelles but without lattice arrangement. Such micelles are termed by Meyer and Mark "mixed micelles" by analogy with "mixed crystals." The great strength of the peptide chains and the bonds holding the micelles together are explained by the high mole cohesion of CONH (10,600), demonstrated by high heat of vaporization, high boiling point, and high dielectric constant. A chain of 100 peptide residues (350 Å.U.), as in fibroin, possesses a mole cohesion of over 1,000,000, very nearly the same as in a cellulose chain.

The micelles are resistant like cellulose to swelling media, in the sense of change of lattice dimensions. Swelling is, therefore, inter-micellar—a proof that within the micelle no free amido- and carboxyl groups exist. Only concentrated acids such as formic and some salt solutions swell to the point of solution.

(b) Tendons, Collagen, Gelatin, and Tissues.—The protein materials in natural fibrous form also produce fiber diffraction patterns. Stretched gelatin films approach

the same structure, though never so perfectly crystalline evidently because the ends of the micelles are ragged. The identity period for tendon is 8.4 Å.U., distinctly different from the value 7.0 in silk. A different arrangement of the chains is indicated, as is found for rubber and gutta percha. All properties indicate that a tendon is constructed similarly to racked rubber; heating causes contraction and disappearance of the fiber patterns. Hence here again are long chain molecules in parallel orientation in bundles, a structure further verified by lengthwise splitting when frozen in liquid air.

Strength is obtained by such a structure as shown by the fact that fresh tendon has a tensile strength of 11 kg./mm.^{2}; after contraction at 80° C., 3.0 kg./ mm.^{2}, and after stretching back to the original length 10.6.

Botanical tissues are webs spun from long primary valence chains, held by molecular cohesion of unsolvated groups or by chemical bridges. The chains may carry solvated shells on the polar or ionizable groups to account for the familiar freshness. Similarly, animal tissues are webs of protein chains forming cell walls and accounting for combination with water. The most important difference between tissues, animal and plant, lies in comparative non-elasticity of carbohydrate chains as compared with the pliable protein chain. Seifriz has stated positively as a result of the study of elasticity that the last molecular entity of a living substance must possess an elongated form. Fibrous tissues such as muscles and tendons have principal valence chains parallel to the fiber axes. Tissue sheets such as the fascia have the chains in one plane.

The presence of distinctive larger regularly arranged bundles of these long chains as micelles seems clearly proved in cellulose, stretched rubber, silk fibroin, etc. In other cases, as in unstretched rubber and in tissues, the matter is not altogether settled. Studies of birefringence, of course, prove parallel orientation, and these larger complexes can be proved if the dependence of birefringence on imbibition of liquids with different indices of refraction shows a distinct minimum. The separation of birefringence due to the form of rod-like particles, as distinguished from that of single parallel long molecules (or characteristic birefringence), has actually been accomplished. It is not essential to give the name of "crystalline" to these conceptions of oriented long chains which actually diffract X-rays. A much higher degree of arrangement is implied by "crystalline," since these long molecule chains still possess a rotational degree of freedom and hence are meso-crystalline. For the first time, however, it is possible to attack the complex problems of chemical structures of chains, their positions in organs, the changes of their forms and position, the relation to each other and to the tissue fluidity. These have already been solved for the simpler fiber sections.

One problem to account for is the fact that many tissues which are insoluble in water still yield considerable quantities of protein to the solvent—a fact which demonstrates that the protein could not have been bound in a chemical network.

Przibram (21) has lately demonstrated from biological methods that the genes and even chromatin threads can be measured in length as 10^{-4} to 10^{-5}. The protein molecule is only one power of ten under the size of these powerful biological units.

Coming then to the behavior of living tissues, it has been demonstrated from mechanical and X-ray investigations that in the extended muscle the principal valence chains are in parallel orientation, in the contracted muscle not. A muscle stretched and dried produces a fiber diffraction pattern, while a dried contracted muscle is amorphous, in keeping with the fact that the stretched muscle frozen with liquid air splits into shreds parallel with the fiber axis, while the contracted frozen muscle breaks into small clumps. von Hurthle (22) has shown

Fig. 7. Muscle of uterus.

that the birefringent part of the muscle fibrils is the actual contractile substance. This birefringence decreases with contraction so that it follows that the chains in the contracting fibril lose their parallel orientation. Until recently it has been impossible to prove whether or not this mechanism is operative in truly living muscle. Experiments by Boehm and Schotzky (23) and by Clark and Corrigan (24), utilizing the new high powered X-ray tubes which permit very rapid exposures, have thrown clear light upon uncertainty. Diffraction patterns of living, electrically contracted frog muscle (excited by an applied voltage to tetanus contractions) have previously been procurable at a great sacrifice. As each muscle after killing the frog remains sufficiently fresh for only half a minute, in the path of an intense X-ray beam several hundred muscles have been necessary. Diffraction patterns may now be obtained in two minutes with only six muscles. With the exception that the diffraction ring for water is present, the patterns are the same as for dried muscle. Contracted living muscles show a great decrease in fibering as compared with the muscle at rest.

A plausible mechanism for muscular action can be deduced in terms of inner molecular forces (25). Rubber contracts because of double bonds in the long hydrocarbon chains which cause a spring-like coiling. In muscle protein there are many free basic and acid groups in the chains, since glutaminic acid and arginine and lysine may be derived. At the isoelectric point COO^- and NH_3^+ ions may attract and pull the chain into a close spiral.

In acid or alkaline media, however, COO^- or NH_3^+ ions repel each other and straighten out the chain. In confirmation of different chain configurations casein and hemoglobin form the homogeneous layers in acid or alkaline aqueous solutions 7 or 8 Å.U. thick, while globules form only on a neutral surface.

Hence contraction or expansion resides in the ultimate long chain molecule: since these are bound together by molecular cohesion or bridges throughout the whole length of the muscle, an inner molecular change with changing pH value produces a contraction or expansion on the macroscopic scale. The physiological and chemical changes relating to production and destruction of acid in the muscle, therefore, lead to direct action on the protein chains and account for the mechanical work. The important conception of change in form of the protein chain as a function of the medium may, therefore, be extended to the behavior of protoplasm and to many physiological problems.

The foregoing account of the new knowledge of natural colloidal protein materials is sufficient to indicate the practical value of such methods of study. A technologic application is in the production of improved surgical catgut for ligatures and sutures. Here the process of swelling and tension, referred to so frequently, is highly effective in improving micellar orientation (followed by the X-ray patterns), and tensile strength.

The dispersion and respinning both of silk and of animal tissues is an accomplished procedure, and any desired properties can be obtained in terms of regulation of the variables. In other words, an inferior quality catgut can be vastly improved by these steps just as cotton or rayon can be structurally changed and improved by swelling or dispersion and tension.

In conclusion it may be clearly stated that X-ray diffraction methods and research have already made a highly creditable contribution to the knowledge of structure and practical behavior of colloids of every type from the simplest metal sol to the most complex living tissue. But the beginning only has been made. New progress with this all-powerful vision of matter afforded to men by X-rays will undoubtedly surpass the most enthusiastic imagination.

5. *An Experimental Study of Normal and Pathological Tissues*

On account of the great progress which has been made in the study of complex colloidal materials by means of the X-ray diffraction method as outlined in this paper, it seemed very logical to undertake the investigation of the ultimate molecular structure of actual human tissues, both normal and pathologic. This constitutes, therefore, a new application of the diffraction method and a new method of approach in problems of anatomy, physiology, and pathologic diagnosis. The results of this investigation, which are here reported, must be considered only preliminary and suggestive of possibilities rather than final and complete contribution. It is self-evident that such studies of ultimate fine structure of tissues must be carried on in conjunction with the well established usual methods of diagnosis, particularly microscopic examination. Specimens were obtained through the courtesy and co-operation of local hospitals, and in all but one or two cases freshly excised. The diffraction patterns were prepared immediately following the surgical operation. In all cases here reported the specimen was mounted stationary over the outer pinhole defining the X-ray beam and the pattern was registered on the photographic film at 5 centimeters' distance. Both molybdenum and copper targets were employed. The preliminary results reported here were all obtained on the usual type of X-ray tubes prior to the installation of high intensity tubes which have made possible diffraction patterns in only a few minutes as compared with many hours. Reference has already been made to the study of living frog muscles, alone made possible by the high powered tubes. Other studies in progress with such a tube will be reported in a later paper. A description of this new equipment and the technic employed will be found in a current paper by one of the writers.[2] The technic employed in the studies here reported is precisely the same as that used for the fine structure analysis of rubber, cellulose, and all other chemical and industrial materials. In the following paragraphs is summarized briefly the simple interpretations derived for the various specimens listed. No attempt is made to consider these results in the light of the medical aspects. The purpose is merely to show that the supermicroscopic examination by X-rays leads to some very direct and interesting comparisons and differentiations of normal and pathological tissues. It is the hope that this new method of examination may be taken up in laboratories, where careful correlations of every kind can best be made.

(a) Normal Bone.—In studying osseous tissue a piece of fractured nose bone was used as a specimen. This was carefully cleaned and ground down to a thinness of approximately 0.5 millimeter. The diffraction pattern (Fig. 1) shows a well defined series of continuous rings, indicating definite crystal structure and a random orientation

[2] G. L. Clark and K. E. Corrigan: Ind. Eng. Chem., 1931, XXIII, 815.

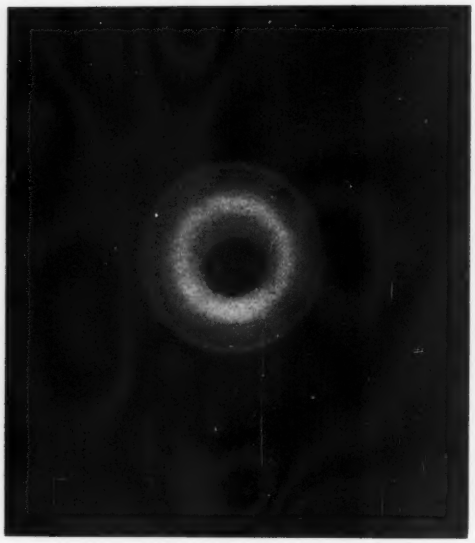


Fig. 8. Bone cancer.

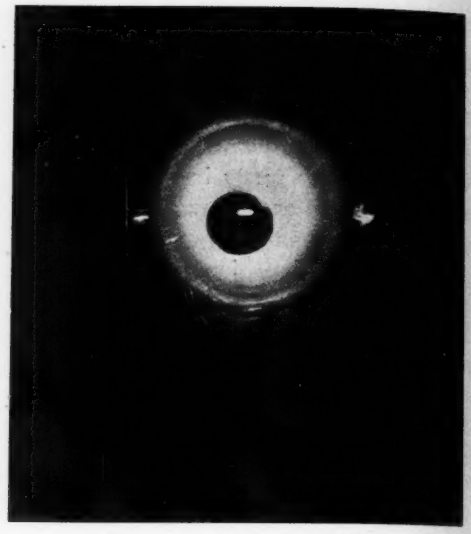


Fig. 9. Osteomyelitis.

of crystal grains. In addition to the sharp diffraction interferences attributable to calcium phosphate, a striking inner broad diffraction ring is apparent, characteristic of the organic constituents of the bone. The characteristic spacings calculated from this pattern from the innermost ring outward are 3.25, 2.96, 2.66, 2.21, 1.86, 1.775, and 1.40.

(b) Normal Tendons.—It was very fortunate at the time of this investigation that a fresh piece of the tendon of the leg was obtained and immediately studied without the use of any preserving agents. A part of the tendon was inclosed in a collodion bag filled with distilled water and carefully sealed. The diffraction pattern revealed a slight amount of preferred orientation (Fig. 2), shown by the appearance of arcs just outside of the continuous inner ring. This fibering was evidently due to the external coating of the specimen. Another portion of the tendon was stretched 100 per cent and kept moist during the photographic exposure with distilled water. The diffraction pattern (Fig. 3) shows a marked change during stretching, inasmuch as it is characteristic of a highly fibered material. The innermost sharp spots correspond to a spacing of 11.09 Å.U. The other sharp arcs correspond to spacings 5.54, 4.21, 3.25, and 2.91. The inner broad ring observed for the unstretched tendon is still present, but has resolved itself into a condition associated with fibering exactly as is found upon stretching gelatin. This ring has also exactly the same characteristic spacing as is found in gelatin. This would suggest the presence of a heavy inner lining of gelatinous material between the connective and muscular tissues. This stretched specimen showed no disintegration and after drying became very tough. A later X-ray examination of this dried specimen showed a retention of the original composition and fibering.

(c) Cartilage.—An attempt was made to study nose cartilage, stretched, but there is practically no difference between the patterns for the stretched and unstretched specimens. The protein molecules undoubtedly form a thick network, which makes preferred orientation practically impossible. An extension of only about 10 per cent is possi-

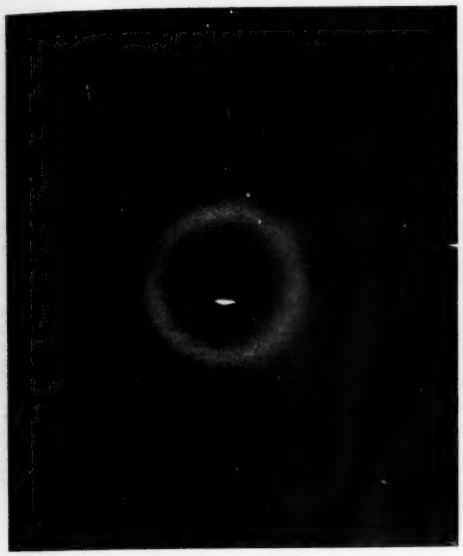


Fig. 10. Breast tumor.

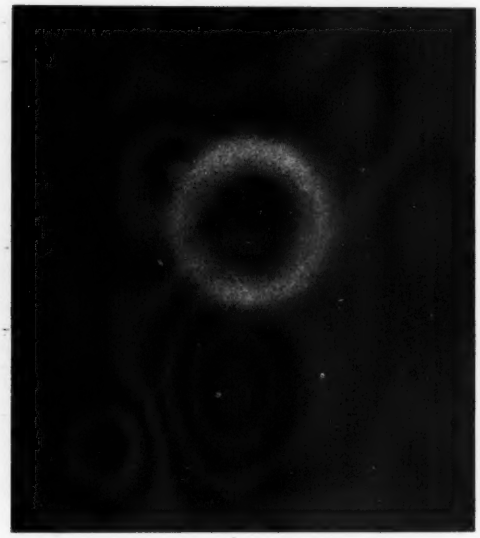


Fig. 11. Carcinoma of the uterus.

ble before rupture takes place. The principal broad diffraction ring corresponds to a spacing of 4.21 Å.U. (Fig. 4). This observation is of importance, as will be noted in the analysis of patterns for bone cancer.

(d) Nerve.—Stretched and unstretched nerve specimens produce essentially the same patterns without indication of preferred orientation. Two or more well defined rings are apparent (Fig. 5), the most intense one corresponding to a spacing of 4.55 Å.U.

(e) Muscle of the Limb.—The diffraction patterns for these muscles are characterized by two or more quite distinctive rings, but there is far less evidence of fibering or preferred orientation than in the case of the dried and living frog muscles referred to above. Upon stretching, the rings became appreciably sharper and there was much less of general scattering, but it has not been possible to produce a fully developed fiber pattern such as was found for a tendon and tor the frog muscles. The spacings for the two principal rings are, respectively, 7.01 and 4.44 (Fig. 6).

(f) Muscle of the Uterus.—This specimen was of unusual interest on account of the fact that patterns were made for different sections; in all cases a very broad and diffuse single ring characteristic of a nearly amorphous substance or mixed micelles was found (Fig. 7). For the transverse section of the cervix the calculated spacing is 3.03 Å.U., for the sagittal section of the corpus 3.59, and for the frontal section of the corpus 3.45. The highly specialized functions which these respective muscles are designed to perform easily account for these variations in fundamental structure. It is not possible to attribute these spacings exactly to any particular part of the molecules. Values of this order of magnitude are evidently associated with a nearly amorphous condition and are smaller than the values usually associated with the cross-section of the molecule. They are, however, highly characteristic, as is demonstrated in the present series of specimens. The network formation is indicated by the fact that

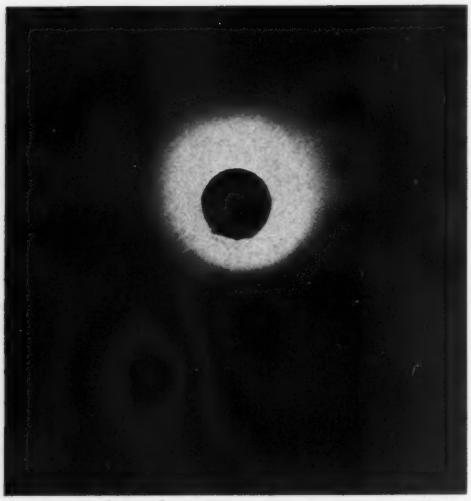


Fig. 12. Fibroma of uterus (early stage).

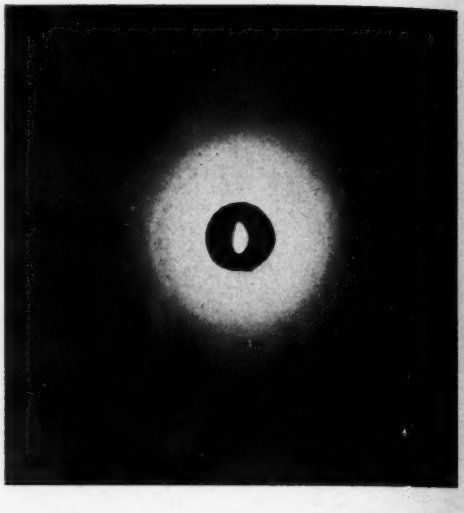


Fig. 13. Fibroma of uterus (advanced stage).

stretching has little effect upon the diffraction pattern.

(g) Bone Cancer.—A specimen of bone cancer revealed the same spacings as osseous tissue, with the exception that an inner intense broad ring made its appearance (Fig. 8). The spacing 4.21 Å.U. corresponds exactly with that observed in cartilage. The other sharp intensity maxima corresponding to the inorganic crystals are still in evidence but somewhat reduced in intensity. The general scattering due to disorganized matter is very much more intense than for normal bone. This indicates that the osseous tissue is being supplanted or at least mixed with a disintegrated material, accounting for the softening of the bone, which in the advanced stages of the condition disintegrates to a soft spongy organic mass. This evidence seems to indicate that the destruction or the supplanting of the osseous tissue takes place through a cartilaginous stage.

(h) Osteomyelitis.—As it is generally defined, osteomyelitis is an inflammation of the bone marrow. In the study of this malignant tissue it is found that the diffraction spacings are identical with those of bone cancer (Fig. 9). In such a preliminary investigation with limited material, it is not possible to be sure that all of the substance examined represents the disintegration attendant on osteomyelitis. Further careful researches should clarify the distinction between bone cancer and this malignant condition designated as osteomyelitis.

(i) Breast Tumor.—Upon investigation of various sarcomas and carcinomas of the breast, failure to distinguish between these malignant tissues arose in determining their various structures. They all appeared to give the same pattern. Whether or not malignant tissue was in its early stage or in the advanced stage made no difference in their spacings. A single diffuse ring similar to those observed for muscles of the uterus is characteristic of a calculated spacing of 3.14 Å.U. (Fig. 10).

(j) Carcinoma of the Uterus.—It was observed above that the definite fundamental spacings for muscles of the uterus depend upon their position and function. Several carcinomas of the cervix and corpus were examined by the diffraction method and all revealed precisely the same spacing for the

Fig. 14. Gallstone (entire).

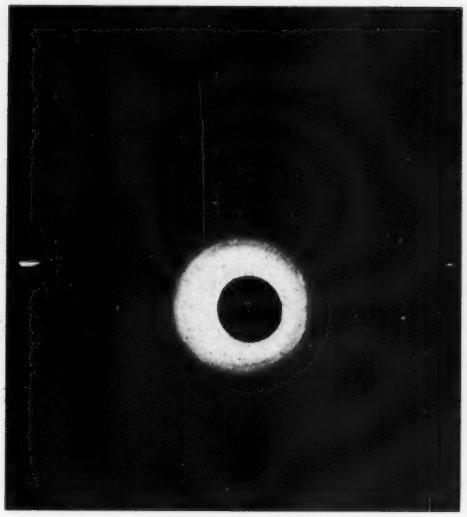


Fig. 15. Gallstone (cut through equator).

principal ring, 3.39 Å.U. (Fig. 11). Since the spacings of these respective sections in the normal uterus were not identical, it is suggested that these malignant tissues are unique in themselves and have but slight relationships to the original structural unit. A much greater general scattering is observed, as would be expected from the presence of disorganized and disintegrated material.

(k) Fibroma of the Uterus.—This abnormal tissue was studied in both early (Fig. 12) and advanced stages (Fig. 13). The early stage, which in some instances is a small bulbous appendage or slight darkening of the tissue, reveals a diffraction pattern which clearly shows the increase in cell size and a more general scattering of a liquid pattern nature. In the advanced stage for a growth of large size in respect to the uterus there appeared very clearly spacings corresponding to osseous tissue. The inner broad diffuse ring of organic origin is retained with a spacing of 4.21. It is a general concept that the fibroma is a tumor made up of connective tissue, but this is not altogether justified by these limited observations. There is unquestionably some inorganic deposition which escapes all detection except when subjected to X-ray diffraction methods.

(l) Gallstones.—The study of soft gallstones was included as a means of investigating possible cause of nuclear formation. In Figure 14 the diffraction pattern obtained for an entire gallstone showed a combination of sharp diffraction rings for inorganic substance and one or more broad rings for cholesterol. A section cut through the equator so that the X-ray beam passed through only the central portion of the gallstone gave only the pattern for cholesterol (Fig. 15). Deposition of oxalic acid or similar crystalline substances, therefore, takes place in the outer layers. It should be possible by further studies to identify from the structure of the nuclei the various possible classes of gallstones and to relate them to different pathological conditions.

SUMMARY

1. The fundamental scientific basis of X-ray diffraction by crystal and amorphous

substances is outlined with special reference to the interpretation of X-ray diffraction patterns for colloids.

2. The theory and results of grain size on particle size in the colloidal range, together with the mathematical equations involved are outlined.

3. The direct measurement of colloidal particle size originally reported in RADIOLOGY is summarized.

4. Fifteen typical examples of research on colloidal metals and inorganic compounds are cited to show the scientific and practical value of the X-ray method.

5. The nature of colloidal solutions as revealed by X-ray diffraction method is indicated.

6. The information which can be obtained concerning the structure of highly polymerized organic substances found in nature, from the co-ordinates of the atoms up to the arrangement of the micelles within the substance, is outlined.

7. A tabulation of the consequences of the deductions of the structure for cellulose, rubber, gutta percha, balata, chicle, silk fibroin, tendons, collagen, gelatin, and tissues shows the remarkable advance in knowledge of the building plan of the most complex substances.

8. Experiments on living muscular tissue, utilizing high powered X-ray tubes which make possible very short times of exposure are reported.

9. The results of a series of experiments with normal and pathological human tissues indicate an additional powerful method for the understanding of physiological functions of tissues and the diagnosis of malignant changes in terms of the molecular structure.

BIBLIOGRAPHY

(1) Ztschr. Krist., 1926, LXIV, 115.
(2) Ibid., 1928, LXIX, 271.
(3) Ibid., 1928, LXVI, 637.
(4) Ibid., 1928, LXVIII, 387.
(5) Ibid., 1931, LXXII, 398.
(6) Faraday Society Monograph, March, 1929, p. 387.
(7) RADIOLOGY, July, 1930, XV, 117-122.
(8) CLARK, G. L., and PICKETT, L.W.: Jour. Am. Chem. Soc., February, 1930, LII, 465-479.
(9) PARMELEE, C. W., and BADGER, A. E.: Jour. Glass Technology, 1929, XIII, 285.
CLARK, G. L., and AMBER, C. R.: Jour. Glass Technology, 1929, XIII, 290.
RANDALL, ROOKSBY, and COOPER: Jour. Glass Technology, 1930, XIV, 219.
(10) Ind. Jour. Physics, 1930, V, 473.
(11) Ibid., 1930, IV, 457; V, 525.
(12) Ibid., 1930, V, 345.
(13) Ibid., 1930, IV, 99.
(14) Ibid., 1928, III, 209, 307; 1930, V, 489.
(15) Der Aufbau der Hochpolymeren Organischen Naturstoffe, Leipzig, 1930.
(16) CLARK: Ind. Eng. Chem., 1930, XXII, 474.
(17) Ztschr. f. phys. Chem., 1930, CXLIX, 371; CLI, 145, 163, 172.
(18) Naturwissenschaften, 1930, XLIV, 915.
(19) Kautschuk, 1930, XI, 234.
(20) Ind. Eng. Chem. and Kautschuk, in press.
(21) PRZIBRAM: Der Aufbau der Hochpolymeren Organischen Naturstoffe, Leipzig, 1930, p. 238.
(22) VON HURTHLE: Der Aufbau der Hochpolymeren Organischen Naturstoffe, Leipzig, 1930, p. 239.
(23) Naturwissenschaften, 1930, XVIII, 282.
(24) CLARK, G. L., and CORRIGAN, K. E.: Ind. Eng. Chem., 1931, XXIII, 815.
(25) MEYER and MARK: The Structure of Highly Polymerized Organic Substances Found in Nature, p. 238.

DISCUSSION

DR. ERNST A. POHLE (Madison, Wisc.): The paper which Professor Clark just presented is certainly most interesting and fundamental, because it opens up an entirely new field for the use of roentgen rays. It bridges the gap between the work of the pure scientist in physics and chemistry and that of the biologist, or, in other words, between matter in general and the living cell. While I have not done any work of my own along these lines, the evidence presented here to-day has convinced me that this method of studying and analyzing tissues by roentgen rays should be developed further.

Let us consider for a moment a few of the slides shown by the speaker. He demonstrated, for instance, that specimens taken from different sections of the same uterus produced different patterns, and also that there is certainly a striking difference between the patterns of normal and of pathologic tissue. If we can learn how to interpret these diffraction patterns and correlate them with clinical facts,

it is quite possible that some day we may have a valuable diagnostic method at our disposal. Perhaps we can also learn more about functional changes in cellular systems. The field of X-ray analysis, if I may term it so, begins where the microscopic visualization ends, since it analyzes molecular structure. This does not mean, of course, that we can discard the microscope to-morrow, since we are, as Professor Clark has very clearly stated, just at the very edge of a most interesting field of investigation. But I sincerely hope that biologists and clinicians will join now in working out this method along the lines which Professor Clark and his co-workers have indicated to us.

Dr. Francis Carter Wood (New York City): In all our problems in medicine and pathology, we are always looking for new technics and cannot but welcome a method for studying molecular and atomic co-ordination and arrangement in the tissues. However, I doubt whether we shall within a very short time be diagnosing cancer by X-ray patterns: I think we will still stick to our microscopic picture. For example, take the question of uterine musculature—we must differentiate between two things, the muscle and the connective tissue, and as there are in different parts of the uterus more muscle or less, more connective tissue or less, the diffraction patterns of the two have to be separated, whereas, with the microscope, we can see the cells that are misbehaving and make a diagnosis more easily and more simply than with any such complex procedure as these roentgen patterns. So that it seems to me that the promise of such work is not so much a practical one at the present moment, but a new type of research which may be of the utmost importance. I should be unwilling to believe that the cancer cell has a special diffraction pattern, because a person may have a piece of liver in his lung which has the same structure as the liver, secreting bile and presumably manufacturing bile acids, and that tissue is called cancer only because it is out of place, not because its morphology is different. In other words, the structure of such a tumor happens not to differ in the least from the normal liver and is doing exactly what the normal liver does, that is, it makes bile pigments and bile acids, so that we have cancers with no differentiation practically, and cancers with high differentiation and the diffraction pattern will be the same as that of the normal cell. However, what will ultimately be practical is very difficult to say, when we see the engineers studying the Raman scattering in order to find out which is the best gasoline for the use of motor cars. It would scarcely have been supposed that such a phenomenon, which is different, of course, from the one described, would ever be of any practical value at all. So that, it may be, I will have to change my opinion in the future and make diagnoses of cancer from X-ray patterns, but it seems a long step. Anything of this sort, however, is immensely valuable in revealing the structures of organized materials. We do not have to synthesize cancer—unfortunately that comes without our asking for it—but I am delighted to see this sort of work presented before this Society, because it clears up things that are very dark and hints towards future possibilities, of the range of which we have no conception.

Dr. Clark (closing): I am very glad indeed that Dr. Wood has made the point so clear as he has. Obviously this is entirely a research matter at the present time. Our interest was enlisted from the humanitarian point of view, without knowing much about tissues, I can assure you, but also to try to get at the mechanism of certain actions, such as the extension and contraction of the muscles. What is contractivity in a molecule, for example? And the picture has become quite perfect indeed. It is a model or a picture as to what actually happens in muscle fiber or these other things when they are stretched or contracted, and fits very beautifully our conception of chemistry, where we have in the unstretched condition a sort of spiral, a molecule like a spring all tightened up together. And then in acid or alkaline media we have certain groups of these protein changes repulsing each other and stretching out the molecules in a fashion which certainly indicates, at least from a mechanistic point of view, what is going on

when we move and extend the muscles of our arms.

Of course this work was never meant and never will be meant to supplant microscopic work: such is entirely out of the question. The X-ray method simply attaches itself on to the microscopic field, penetrates more deeply down into molecular structures. I feel that, as a research method in the future, since we have just barely started, it will give us some types of information which will add to the whole picture through which we will solve some of the complexities and meet all of the efforts of everyone with every possible kind of method, chemical, physical, physiological, to finally solve this problem. This is only just one of the methods of approach. Of course, we feel so enthusiastic because we are talking of our beloved tool, as it were, and putting it to another use.

SCIENCE PENETRATES STRUCTURES OF WOOD AND RUBBER

BERLIN.—Rubber and cellulose are no longer the mysteries they once were, as a result of the work of Prof. Kurt H. Meyer and Dr. H. Mark of the I. G. Farbenindustrie A. G.

By correlating the evidence from X-ray and chemical investigations with those of microscopic form it is now possible to have a clear idea of the arrangement of the atoms in the peculiarly complex structures of the natural substances constituting this paper or your tires.

It is easy to understand how a simpler substance like sugar, for instance, is built up as there the molecular units are laid regularly side by side like the bricks in a wall. The molecules of cellulose, the tough, fibrous material of wood, cotton, linen, and paper, or the carbon and hydrogen atoms of rubber, however, are linked together in a network resembling a sponge where it is difficult to say where one leaves off and the next begins.

—*Science Service.*

SO-CALLED CALCIFYING SUBACROMIAL BURSITIS

By JOHN BERTON CARNETT, M.D., PHILADELPHIA
Professor of Surgery in the Graduate School of Medicine of the University of Pennsylvania

CODMAN, in 1906, was the first to describe the symptom-complex which he designated as "subacromial bursitis." He had not found any calcareous deposits in the cases he then reported. The following year Painter and Baer both reported cases of calcareous deposits and, in the light of present-day knowledge, they were probably both in error in stating that the deposits were situated in the wall of the bursa. They each reported having excised the entire subdeltoid bursa in four cases. Unfortunately many writers have wrongly followed their lead and described the deposits as occurring in the wall of the subacromial bursa and advised total excision of the bursa. Codman was the first to point out that the deposit is located beneath the bursa, in or on the supraspinatus tendon. It is most important for surgeons to realize that the deposit is not in the bursa but beneath its floor, in, on, or even under the supraspinatus tendon, otherwise they are likely to miss it at operation as did Painter in two of his four early operations, in which he reported excision of the subdeltoid bursa, and as did Stern, who probably limited his search to the interior of the bursa.

Some confusion has arisen in the literature because various authors use the terms "subacromial bursa" and "subdeltoid bursa" as synonymous and interchangeable, whereas others regard them as separate entities. Experience has shown that there is only the one bursa and the general trend of opinion is to call it "subacromial."

The subacromial bursa is nearly as large as the palm of the hand of the individual in

Fig. 1-*A*. Two large deposits in space between acromion and humerus.

Fig. 1-*B*. Same case after five weeks, showing partial absorption and recent fracture in deposit as indicated by arrows.

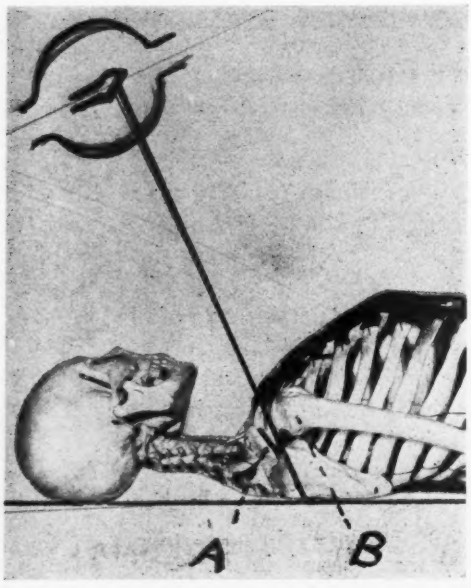


Fig. 2. *A* indicates acromion process and *B* the humeral head. Caudad angle for central rays to show clear space between head of humerus and acromion. The tube is also placed mesially to shoulder to direct rays outward. Target distance of 40 inches. *Courtesy of Dr. J. Gershon-Cohen.*

whom it is located, and, except for a small projection beneath the deltoid muscle, lies between the acromion process and the head of the humerus, where it is inaccessible for the complete excision so commonly and wrongly advised by numerous writers.

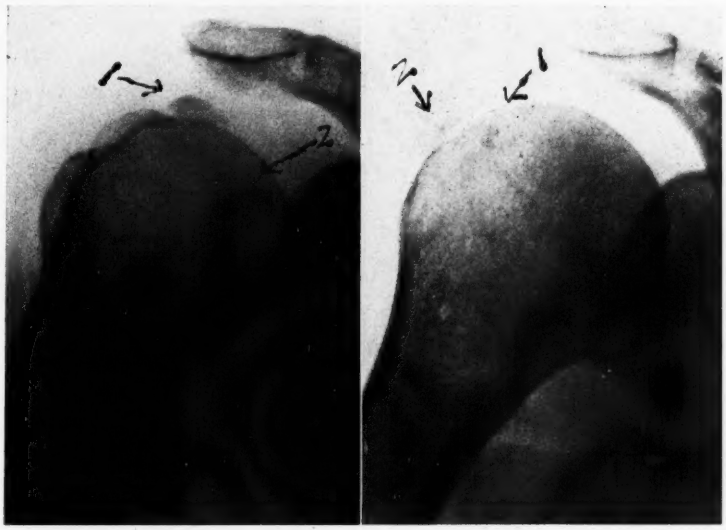
In many of the cases with typical acute or chronic symptoms that are studied carefully at operation, the opened subacromial bursa is found to be entirely free from any pathologic changes, and the deposit is found in or even under the supraspinatus tendon. It, therefore, seems obvious that the symptoms must be caused by the tendon lesion and that the term "bursitis" is really a misnomer. Often a localized or rarely a diffused bursitis may co-exist and is probably induced by the adjacent tendon lesion, but the symptoms in no way differ from the cases in which the tendon alone is affected.

Codman believes the deposits are due primarily to acute traumatic rupture of a few fibers of the supraspinatus tendon, with the occurrence at the site of rupture of a hematoma in which calcium salts are deposited. It is to be noted, however, that (1) many intelligent patients cannot recall any history of trauma that might cause tendon rupture; (2) calcareous deposits may be present for years without causing symptoms, and (3) mild trauma may incite symptoms in a previously quiescent deposit. Because of these clinical observations and because of

Fig. 3-*A*. Too great caudad angle of central ray projects into clear space, the anterior lip of acromion simulating large deposit similar to Figure 1. The fallacy is shown by the articulation of the clavicle with the apparent deposit.

Fig. 3-*B*. Same shoulder fails to show any semblance of deposit by proper technic.

Case and Moschowitz having found the pathologic lesions to consist of tendinitis, necrosis of tendon, and deposition of calcium, the latter occurring often in multiple foci even up to 500 or 1,000 in number, it would seem the lesion is not due to a single acute trauma but, rather, to the million-fold occupational traumas of pinching the supraspinatus tendon between the grip of the humeral head and the acromial process or acromio-coracoid ligament.



Figs. 4-*A* and 4-*B*. Two dense deposits. (*A*) Internal rotation showing Deposit 1 clear of humerus and Deposit 2 obscured by humeral shadow. (*B*) External rotation. Deposit 1 now obscured and Deposit 2 clear of bone.

The symptoms of so-called subacromial bursitis vary considerably in different patients but usually are fairly characteristic. The symptoms may run an acute, chronic, or intermittent course. In the acute cases the pain may be exceedingly severe, requiring huge doses of morphine for its control. It may extend from the neck to the finger tips or from the shoulder to the elbow. Usually the severest pain is experienced not at the site of the deposit but in the lower deltoid region. The symptoms are those of a more or less extensive brachial neuralgia. The most common cause of brachial neuralgia is subacromial bursitis. The roentgenologist should bear this latter statement in mind and when patients are sent to him with a diagnosis of brachial neuralgia or neuritis and a request that search be made for a toxic focus in teeth, sinuses, or gastro-intestinal tract, he will frequently find that a roentgenogram of the shoulder, taken by the proper technic, will reveal calcifying bursitis. Removal of tonsils, infected teeth, or other toxic foci does not benefit neuralgia due to bursitis.

Bursitis neuralgia differs from other forms of brachial neuralgia in two respects: in bursitis, there is (1) a sharply localized tender spot just below the acromion process, somewhere between the lesser tuberosity and the outer aspect of the humeral head; (2) there is great restriction of shoulder motion both actively and passively, particularly in the direction of abduction and internal rotation of the humerus.

Fig. 5-*A*. External rotation demonstrates dumb-bell-shaped deposit.

Fig. 5-*B*. Same deposit as shown in Figure 5-*A*, blotted out by humerus in internal rotation.

Patients with acute bursitis have severe pain for from one to three or four weeks. Usually the acute pain then subsides and full recovery commonly occurs, but in a small percentage of cases symptoms in very much milder form may persist or intermit for many years.

The more severe the attack the more likely is the deposit to undergo spontaneous absorption in the course of several weeks or a few months as a result of the inflammatory increase in blood supply. Symptoms may persist in mild form for some months after complete disappearance of the deposit; it, therefore, follows that roentgenograms of the shoulder taken several weeks after the acute period of an attack may fail to show the deposit which originally caused the attack but which has since disappeared. Roentgenograms should be made of both shoulders even when all the symptoms are confined to one shoulder. In 25 per cent of the cases a deposit is found in the symptomless shoulder. The finding of a deposit on the symptomless side only in a patient who has passed through an acute attack several weeks earlier indicates that originally he had bilateral deposits, with subsequent spontaneous absorption in the painful shoulder. A deposit in a symptomless shoulder may develop characteristic symptoms months or years later. The milder degrees of so-called acute bursitis symptoms may occur in the absence of a deposit, probably due simply to an inflammation in the supraspinatus tendon. In a small percentage of such cases with prolonged symptoms a deposit may occur subsequently as shown by the X-ray.

Fig. 6-*A*. External rotation discloses enchondromatous osteophyte near greater tuberosity.

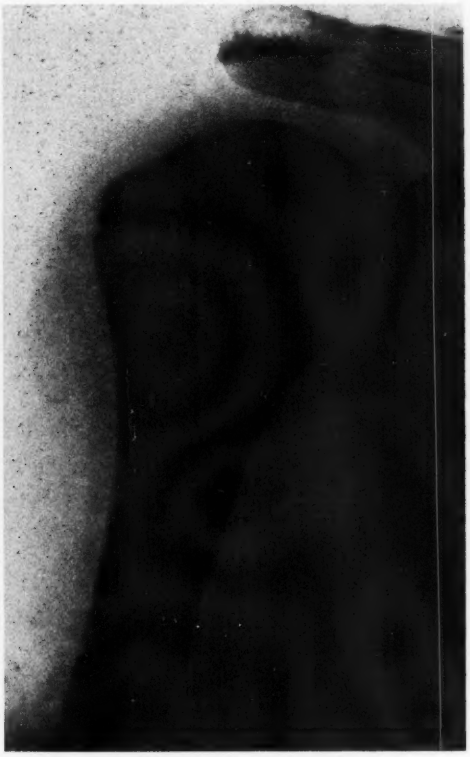
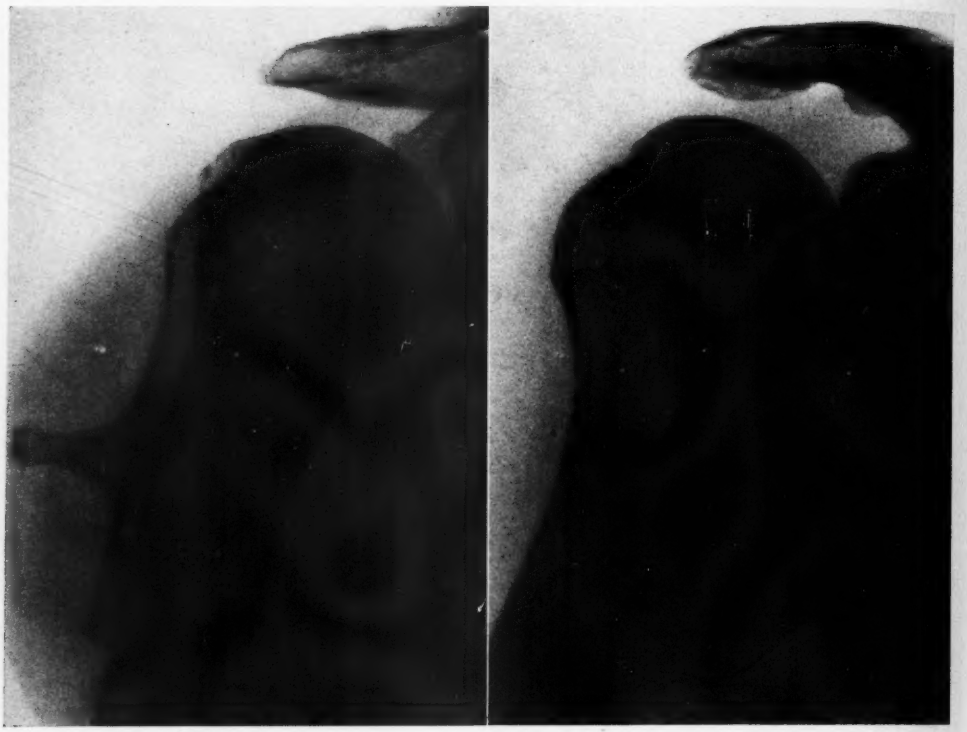


Fig. 6-*B*. The usual shoulder exposure (internal rotation) fails to give any hint of this lesion. Clinical symptoms simulate bursitis.

The chronic cases of so-called bursitis may pursue a mild course from the start or, exceptionally, they may follow on the subsidence of an acute attack. The symptoms, which may continue for many years, may simply be those of a stiff and painful shoulder. The range of motion, especially in abduction and internal rotation, may or may not be greatly restricted. Restriction of motion is due in the acute cases to pain and muscle spasm and in the chronic cases to contractures of muscles and ligaments from prolonged holding of the arm to the side. The claim that restricted motion in the chronic cases is due to adhesions within the bursa is not borne out by operative findings.

In many of the chronic cases the range of shoulder motion may be complete, but painful during abduction through the arc running from 75 degrees to 95 degrees, due to compression of the sensitive deposit region as it passes under the acromion or acromioclavicular ligament. The preceding may be the only pain some of these patients experience, whereas others have mild forms of brachial neuralgia of variable extent. Some of the chronic cases simulate chronic arthritis but in the latter there is tenderness of the entire circumference of the head of the humerus, whereas in bursitis the tenderness is limited to a definite area smaller than a twenty-five-cent piece at the front of the humerus just below the acromion at the site of the deposit. I have had many of these deposits under observation by roentgenograms over a period of years and have



Figs. 7-*A* and 7-*B*. Large osteophyte, as shown by external rotation *(A)* and by internal rotation *(B)*.

never noted absorption of a deposit except following an acute attack or an acute exacerbation in a chronic case. In a few cases the deposits have increased in size. I have never observed a recurrence after spontaneous absorption or operative removal of a calcareous deposit. Calcifying bursitis is very rare before thirty and occurs usually after forty years of age.

The question of whether or not a deposit is present in any given case—even with perfectly typical clinical symptoms—can be settled only by X-ray examination. The usual technic of taking a roentgenogram of the shoulder may show a calcareous deposit, but it frequently fails to disclose even large deposits. This statement is well illustrated by a patient who had had shoulder symptoms for many years and had sought relief at numerous clinics, both here and abroad, where "dozens of pictures" had been taken, with negative results. The patient demurred at having more taken, but when proper technic was used the deposit shown in Figures 1-*A* and 1-*B* was demonstrated.

To avoid the possibility of missing these deposits a special technic has to be employed, to throw the deposit shadow clear of the bone shadow, otherwise the latter will obscure or entirely blot out the former.

In some of the cases the deposit lies over the summit of the humerus, as in Figure 1, where it will be lost in the superimposed shadows of the posterior portion of the acromion and the head of the humerus, as shown in roentgenograms taken by the usual method of directing the rays from the tube at a right-angle to the shoulder. A clear space

can be shown between the acromion and the humerus by directing the central ray slightly caudad and laterally, usually about 10 degrees from the vertical in each direction (Fig. 2). The angle may often be increased to 15 degrees caudally, but a further increase may project the anterior portion of the acromion in a way to simulate a deposit, as in Figures 3-*A* and 3-*B*.

The more usual location of deposits is at too low a level for the acromial process to obscure them, but even at this lower level they may be completely lost in the shadow of the humeral head. To insure a deposit shadow being thrown free from the humeral shadow two exposures must be made in every case, with the rays directed as previously described to show the clear space between acromion and humerus. One exposure is made with the arm in the position of internal rotation, which is secured by flexing the patient's elbow and resting his palm on his upper abdomen. This position discloses the deposits which are located near the outer side of the shoulder but conceals those near the tuberosity (Figs. 4-*A* and 4-*B*). The second exposure is made with the arm in the position of external rotation by flexing the patient's elbow to a right-angle and keeping it at his side while the back of his hand rests on the X-ray table. Exceptionally external rotation of the arm may be somewhat limited, in which event the patient's body should be turned on the table sufficiently to bring the back of the hand against the table. Deposits located near the greater tuberosity are shown in this position, while they may be completely obscured in the position of internal rotation (Figs. 5-*A* and 5-*B*). Rotation of the humerus may be ob-

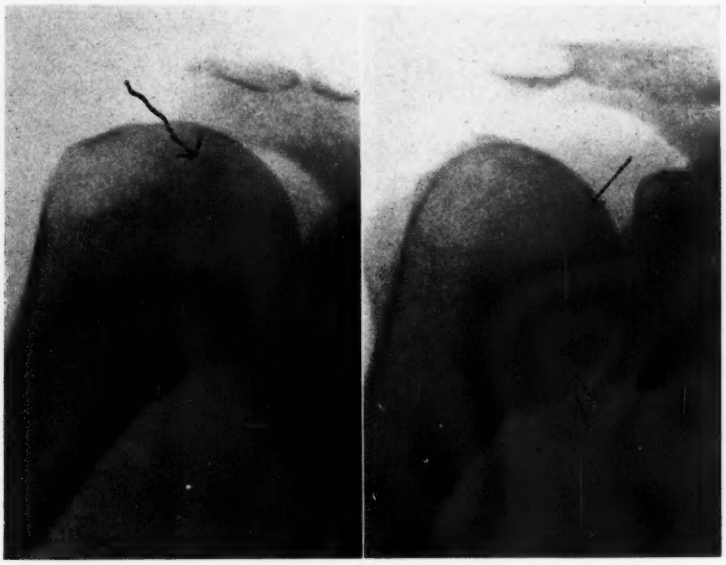


Fig. 8-*A*. Internal rotation. Fig. 8-*B*. External rotation.

Arrows point to areas of osteosclerosis which are located within the humeral head and are not thrown clear of the bone in either extreme of rotation.

Fig. 9-*A*. Original negative film in usual position of internal rotation following automobile accident.

Fig. 9-*B*. Film taken in external rotation a month later revealed two fracture fragments, with corresponding defect in greater tuberosity. Confirmed by operation.

tained with the elbow in full extension by having the patient rest the back of his hand on the table for the position of external rotation, and the radial border of his forearm and hand on the table for full internal rotation.

Unless all the preceding conditions have been fulfilled a negative diagnosis should not be made. With properly exposed films a trained eye is not needful to detect the average deposit, but it is well to know that a deposit causing symptoms may be only pinhead in size. The calcareous deposits are frequently multiple. On the other hand, an apparently single shadow may be found at operation to consist of a number of deposits closely associated. A roentgenologist unfamiliar with calcareous bursitis is apt to diagnose the shadow as a fracture of the greater tuberosity. The technic described is far superior to stereoscopic films for detecting bursitis deposits; the latter are, however, helpful in some cases in proving that a given shadow is attached to the bone (Fig. 6) or lies within its interior (Fig. 8).

Bursitis deposits can usually be visualized during a fluoroscopic examination, provided ample time is spent in the dark room to secure complete sight accommodation.

At operation a very recent deposit may be liquid in consistency and resemble staphylococcic pus in appearance. With the lapse of time the fluid is absorbed and usually the deposit has the consistency of the contents of a sebaceous cyst. Deposits of longer duration have a granular, gritty consistency, and in one instance Case found true bone formation. Cultures from the deposit are always sterile.

The treatment of calcifying subacromial bursitis may be either medical or operative. Society women who object to a scar on the upper arm usually elect medical treatment, which consists in holding the arm in abduc-

tion, applying heat, and giving sedatives for pain during the acute stage, while awaiting Nature's efforts to effect spontaneous absorption. Men and working women who do not object to a scar usually elect operative removal, because operation is safe and simple and much the promptest method of restoring full function, free from pain.

Roentgenologists habitually make two right-angled views of the extremities, except in the upper arm, where they resort to a stereoscopic view, because they apparently are not familiar with the method of rotating the humerus to obtain right-angled views of its upper end. By the technic described for taking roentgenograms of bursitis deposits, internal rotation gives an antero-posterior view and external rotation gives a lateral view of the humerus. The method is not suitable, as a rule, for recent fractures through the shaft, but its routine use has proved most helpful in all other examinations of the shoulder and upper humerus, as in foreign bodies, arthritis, localized disease in the upper humerus (Figs 6-*A* and 6-*B*, 7-*A* and 7-*B*, and 8-*A* and 8-*B*), fractures of the acromion or tuberosities (Figs. 9-*A* and 9-*B*), and incomplete fractures of the humeral head, several of which are illustrated by roentgenograms made by Dr. George E. Pfahler and Dr. J. Gershon-Cohen at the Graduate Hospital. No other method has given as good results in detecting the calcareous deposits of so-called subacromial bursitis.

BIBLIOGRAPHY

1. Baer, W. S.: Bull. Johns Hopkins Hosp., 1907, CXCV, 282.
2. Carnett, J. B.: The Calcareous Deposits of So-called Calcifying Subacromial Bursitis. Surg., Gynec. and Obst., October, 1925, 404-421.
3. Carnett, J. B., and Case, E. A.: A Clinical and Pathological Discussion of So-called Subacromial Bursitis. Surg. Clin. N. Am., October, 1929, pp. 1107-1126.
4. Carnett, J. B.: So-called Subacromial Bursitis. Surg. Clin. N. Am., December, 1930, pp. 1309-1317.
5. Codman, E. A.: Boston Med. and Surg. Jour., 1906, CLIV, 613.
6. Moschowitz, E.: Proc. New York Path. Soc., 1915, n.s. XV, 1-7.
7. Painter, C. F.: Boston Med. and Surg. Jour., 1907, CLVI, 345.
8. Stern, W. G.: Surg., Gynec. and Obst., January, 1925, XL, 92-94.

THE ROENTGENOLOGIC DIAGNOSIS OF HYPERPLASIAS OF THE GASTRIC MUCOSA[1]

By DR. FRANZ WINDHOLZ, VIENNA
From the Central Roentgen Institute of the Allgemeines Krankenhaus in Vienna
Director: Hofrat Prof. Dr. G. Holzknecht

Translation by H. W. HEFKE, M.D., MILWAUKEE, WISCONSIN

MORPHOLOGIC changes of the gastric mucosa have formerly been investigated only by pathologists. They played a minor rôle in clinical medicine, because they could not be demonstrated during the life of the patient. These changes do not give rise to any clinical symptoms, except when they represent a definite disease-entity; they have been, therefore, of interest only from a pathologic-anatomical standpoint.

Only since the changes of the relief of the gastric mucosa and rugæ have been studied roentgenologically by Holzknecht and his school (Eisler and Lenk), and since the part the mucosa plays in the physiological (Forssell) and pathologic (H. H. Berg) formation of the relief has been demonstrated, have anatomical changes of a diseased mucosa gained in clinical importance. Perfected roentgenologic technic has helped considerably to bring this about. Our knowledge of changes in the surface of the mucosa, especially in hyperplasias, when transitions from the physiological to the pathological and from benign to malignant are difficult to judge, is imperfect even as far as the pathologic basis for roentgenologic symptoms is concerned.

In previous articles I have reported peculiar and permanent changes in the gastric mucosa in cases of chronic gastritis. I have endeavored especially to compare the roentgenologic appearance of a hyperplastic mucosa with the anatomical findings. These changes do not appear only in a definite form of the mucosa-relief, but also in definite histological features. The height and thickness of the rugæ excel even those usually found in a chronic hypertrophic gastritis; the course of the folds, however, remains more or less typical for a certain portion of the stomach (isthmus region, respectively, corpus) (Fig. 1). A transverse section through the anatomical specimen shows this best; the rugæ are high (1 to 1.5 cm.) and partly branched (Fig. 2). These changes take place in older patients and spread from the greater curvature to the anterior and posterior walls of the stomach. Toward the pyloric end and the cardia the folds gradually merge into the more normal parts of the mucosa. The adjacent portions of the canalis may also be affected; the antrum and the cardiac end of the corpus, however, remain free from marked changes.

The most predominant histologic change is an excessive diffuse increase in the number of the glands that differentiates chronic gastritis to a certain degree from the other forms of glandular hyperplasia. A change in the architecture of the mucosa offers another point in differentiation. The layers of the mucosa lose their proportions: the width of the gastric crypts compared to the thickness of the glandular layer is proportionally as 1 to 4 or 1 to 5, instead of as 1 to 1 or 1 to 2, as in normal cases (Kalima). Microscopically, on viewing larger portions of the mucosa, one gets the impression of diffuse adenomas (Fig. 3). The interglandular tissue is markedly reduced. This marked proliferative tendency of the newly formed glandular elements leads to the formation of true circumscribed adenomas in some places; they may be surrounded by connective tissue,

[1]Read in part in the Wiener Roentgengesellschaft, March 4, 1930.

which looks like a capsule. Some of these adenomas consist of cylindrical cells with a transparent protoplasm and round basal nuclei which, densely grouped together, surround the narrow lumina. I have reason to believe from histologic studies that some of these adenomas originate from immature cells in the proliferative zone of the glandular neck. Some adenomas, especially the ones characterized by the presence of clear cells, might originate from the vestibular glands, the interglandular cells of Aschoff. These are histogenetically apparently the same as the pseudopyloric glands of Stoerck and probably also the same as the proliferating cells of Kalima.

These histologic peculiarities separate this group from the better known forms of hyperplasias of the mucosa (polyadénies of Menétriérs). Since one has learned to use only small amounts of contrast medium and compression serialographs in the roentgenologic examination, one can demonstrate these anomalies roentgenologically. The differentiation of this form of hyperplasia from the circumscribed form *(Polyadénie*

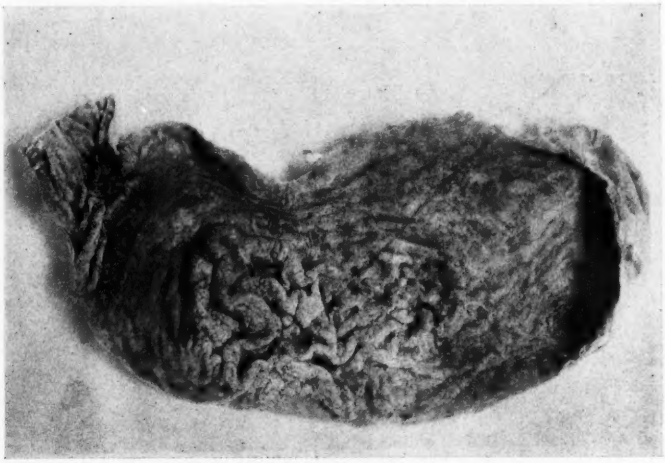


Fig. 1. Considerable hyperplasia of the rugæ in the region of the isthmus extending into the region of the canalis.

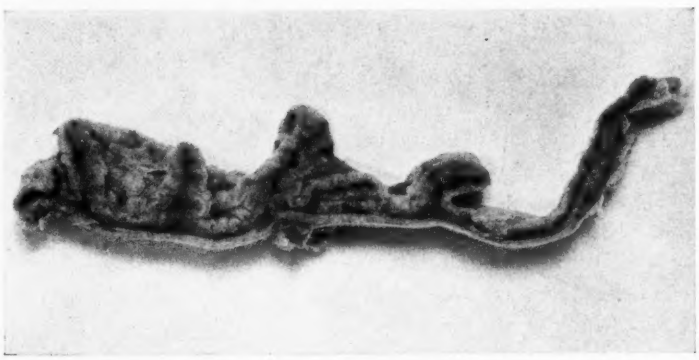


Fig. 2. Transverse section through the wall of the stomach in the region of the isthmus. Markedly thickened and elongated mucosa-folds.

en nappe, polyadénie polypeuse) can be made in about the same way as the anatomical differentiation has indicated.[2]

The normal roentgenologic appearance of the mucosa in the region of the median part of the folds. The folds which run in an antero-posterior direction become visible as notches in the contour. The normal caliber of the folds compares roentgenologically with that of a pencil. It remains constant,

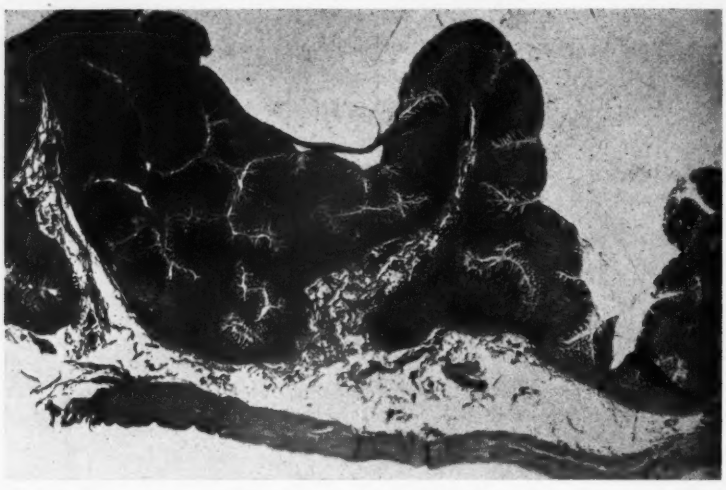


Fig. 3. Low power microscopic sectional view of Figure 2 (Zeiss Planar No. 5; eosin-stain) hematoxylin.

of the greater curvature is different from that of the other parts of the stomach; one finds here, besides longitudinal, also transverse folds. These transverse folds are considered by some to be real and constant structures; others believe they are only spiral and corkscrew-like windings of the longitudinal folds, and compare them, especially in the corpus region, with the brain convolutions. Their roentgenologic symptomatology and the technic of their demonstration have been described masterfully by H. H. Berg in his recent book. It will suffice to quote only his statement that the elevations and valleys of the folds cause a more or less serrated appearance of the profile in the region of the greater curvature, corresponding with the winding course even if the mucosa contracts markedly; only the height is somewhat increased and the course of the folds is more irregular (H. H. Berg). In the anatomical specimen one can normally see a characteristic constriction of the stomach, forming a narrow pass through it. The rugæ wrinkle together in this area in such a way that only a narrow canal remains (Volkmann).

In inflammatory hyperplasias of the mucosa one sees, roentgenologically as well as pathologically, mostly an increase in the caliber of the folds caused by a widening and swelling and correspondingly deeper valleys between them. The roentgenologic appearance of the folds becomes higher, thicker, and wider (Fig. 4). The motility of the folds is somewhat decreased; the mucosa is less flexible than normal. This stiffness is sometimes so marked that it may be

[2]The author calls this type "isthmuspolyadeny"; thus not only is its morphological structure, but also its most frequent location indicated.

demonstrated even in a stomach completely filled with barium (see the classical observations of Haudek and G. Schwarz). It is found commonly in the corpus and canalis in cases of chronic gastritis, but occasionally

Fig. 4. Roentgenologic appearance of the mucosa in chronic hyperplastic gastritis. (Roentgenogram made by Dr. Karl Presser.)

it may be seen in the region of the antrum. The roentgenologic appearance of the mucosa in these cases seems to correspond with the "antrum-gastritis" of Konjetzny. The changes stop in the vestibular region. In other cases the region of the antrum is comparatively free and the changes typical for a chronic gastritis are more marked in the corpus.

Besides these two forms of hyperplasia of the mucosa one can occasionally see similar changes in the isthmus and the neighboring parts of the canalis and corpus. The roentgenologic examination shows high, non-flexible folds, protruding into the lumen of the stomach like an arch (Fig. 5); they are seen to be single as well as multiple and localized elsewhere than in the isthmus, although the most pronounced changes are found there. In some cases they are present also in the regions of the pylorus and the cardia (Fig. 6). The large, arcuate, constant negative shadows of the hypertrophied

Fig. 5. Thick, arcuate, hyperplastic folds protruding into the lumen of the stomach in the corpus and isthmus; clinically suspicious of carcinoma. No progressive changes in one and one-half years. (Roentgenogram taken by Dr. Karl Presser.)

folds merge without interruption with the normal or thickened rugæ. In our cases the changes were constant for a year on repeated examinations. They are apparently equivalent to the anatomical changes found in the isthmuspolyadeny of the stomach, and are permanent. The size and shape of the anomalous folds in the isthmus region and in the anatomical specimen correspond with the changes in the mucosa as seen roentgenologically. Anatomically these changes are marked, especially by the definite increase in thickness and height of the folds (up to 1.5 cm. in the fixed specimen); their normal course is not changed on the whole. The large, arcuate, negative shadows in the region of the isthmus, shown in the roentgenograms, must, therefore, represent the transverse or diagonal projection of the high folds as seen in isthmuspolyadeny. Typical for this anomaly is the absence of a diffuse

hyperplasia of the mucosa, seen in the entire corpus and antrum or isolated in the latter.

The isthmuspolyadeny can obviously be observed anatomically and roentgenologically in about the same percentage of cases;

Fig. 6. Very definite, high and arcuate hyperplastic rugæ in the region of the isthmus and canalis; 42-year-old man under observation for one year. (From H. H. Berg's text, page 105.)

but definite statements cannot be made about it as statistics are not available as yet. In the pathologic-anatomical material cases of the pathologic department of the Krankenanstalt Rudolfsstiftung (Director: Prof. Priesel) (autopsies and operative specimens), I found the above described changes only twice in more than three thousand stomachs. In the roentgenologic institute of Holzknecht only one such case has been seen during the last few years. In the roentgenologic as well as in the anatomical cases this anomaly was observed in a comparatively advanced age. The clinical symptoms were rather vague.

The roentgenologic diagnosis of an isthmuspolyadeny is easy, if small amounts of the contrast medium are given and if compression serialographs are used. I would like to mention, however, that occasionally an overlapping of the rugæ, with an apparent increase in height and disappearance of the valleys, may simulate the picture of an isthmuspolyadeny; but these changes are not constant, contrary to the above described anomaly. Sometimes they have already disappeared at re-examination. The stiffness of the folds, seen also when compression is used, and seen constantly at repeated examinations, will assist in the differential diagnosis. Real difficulties arise only in the differentiation of the polyadeny from true neoplastic changes of the mucosa. However, the border of the enlarged folds is sharp; their course remains undisturbed even in the close vicinity of the most marked changes; there is no abrupt demarcation, and the enlarged and thickened folds run in the same direction as the normal folds, a fact which is opposed to a diagnosis of carcinoma (Berg). If one remembers these facts, then the first examination may to a certain degree indicate the benign nature of the changes. But only repeated examinations can determine whether these findings indicate an isthmuspolyadeny or only an overlapping of normal rugæ or a neoplasm.

It is understood that this roentgenologic differentiation from malignant tumors pertains only to tumors which grow by expansion. One can state only after re-examination, repeated for months or years, whether or not there is an infiltrative growth of excessively regenerating epithelium. Only thus may one prove the stationary nature and the absence of infiltrative changes.

The diagnosis of an isthmuspolyadeny is of clinical importance mostly in that one may differentiate it from a malignant tumor. Its occurrence seems to be a certain sign of a chronic hyperplastic gastritis localized in the isthmus, which has led to a more excessive regeneration of the mucosa. The therapeutic indications will be dependent on the clinician's opinion about the problem of gastritis and on his opinion about the relationship of gastritis to potential malignancy. The number of such cases examined by us is much too small to allow us to form an

opinion on the question. I would like to mention that I could demonstrate a few heterotopic gland structures in the muscularis mucosæ in the neighborhood of a proliferating adenoma, but they showed all histologic marks of benign growths. Repeated roentgenologic examinations extending over a year and longer did not reveal signs of progressive growth in the clinical cases. According to Konjetzny and Puhl the forms of gastritis leading to malignancies are diffuse, and cause atrophic changes of the mucosa (see also Orator). Lubarsch likewise calls the types of gastritis which may be the starting point for a carcinoma, gastritis chronica atrophicans progressiva. In our cases we dealt not at all with diffuse atrophic, but with localized hypertrophic changes of the mucous membrane. The changes necessary for the development of cancer are not present in the isthmuspolyadeny.

Clinically our cases showed only slight and uncertain symptoms. Signs of insufficient secretory function were absent and could not even be expected. Aschoff believes that the function of the glands in the vestibulum is different from that of the glands of the corpus. An absence of secreting vestibular glands and their substitution by "indifferent" glands does not prove an insufficiency of the glands of the corpus or the pylorus. The hyperplasia of the mucosa and the disturbance in function are both caused by the same agent, but one is not dependent on the other.

The etiology of the polyadeny can probably best be explained by inflammatory catabiotic changes in the mucous membrane, as Feyrter recently showed for the glandular hyperplasias and tumors of the gastrointestinal tract in extensive and precise studies. In favor of this in our case are also the marked interstitial inflammatory changes, demonstrable microscopically in the mucosa surrounding the lesion. The isthmus, especially in the region of the lesser curvature, is especially liable to morbid changes on account of its situation; the chyme must be pushed through this narrow path with special force. Aschoff has used this fact for his theory about the etiology of gastric ulcers. The region of the greater curvature is comparatively immune from mechanical insults by the protection of overlapping folds of the anterior and posterior wall. The fact that other pathologic changes are rare on the greater curvature side of the isthmus on account of the protection afforded by the folds, well explains the rare occurrence of the isthmuspolyadeny. A fixation of the mucosa, as may take place in the motor insufficiency of the muscularis, may cause an irreversible change in the form of the folds, just as diseases of the muscles of the skeleton may cause an ankylosis of joints. It is obvious that the gastric rugæ, after such change has taken place, lose their protective effect in the above mentioned sense, and that they offer a good field for progressive pathologic changes.

Indeed, the histologic examination has shown definite and extensive areas of destruction of the muscularis mucosæ in the region of the diseased mucosa. Cellular infiltration and newly formed capillaries were present in the muscularis; in many parts it was absent and its place was taken by connective tissue. It seems possible, therefore, that the disturbed function of the muscularis mucosæ and the lack of protection for the greater curvature following it may have led to a progression in the localized catabiotic changes and furthermore to the permanent changes of the mucosa, as demonstrable in roentgenograms.

QUANTITATIVE ROENTGEN DIAGNOSIS OF PLEURAL EFFUSIONS[1]

By MAJOR ALBERT BOWEN, M.C., U. S. A., DENVER, COLORADO

POSTMORTEM roentgenograms are made routinely at Fitzsimons General Hospital. This procedure has been adopted for the purpose of roentgenologic study and because often valuable data are gained for use in presentation of the case at autopsy. Frequently, the immediate cause of death, while recognized clinically, cannot be demonstrated upon the routinely made roentgenograms because they antedate the development of the pathology which really was the immediate cause of death. All in all, postmortem X-rays have been a most valuable aid to clinicians, pathologists, and roentgenologists at this hospital.

One of the interesting facts noted by this procedure was the failure of rather large pleural effusions to cast a characteristic shadow upon the postmortem X-ray film, although demonstrated to be present at the autopsy. Then too, it was noted that in cases of bilateral effusions the X-ray interpretation was not correct as to which side of the chest contained the larger quantity of fluid. The confusion in cases of effusion so studied was not caused because of a difference in the character of the pleural fluid since the cases studied were pleural effusions occurring in terminal cases of pulmonary tuberculosis and were essentially of the same character.

If the failure of the pleural effusions to cast a shadow is not due to a difference in the character of the fluid, the question of the distribution of the fluid must be considered. It was noted in autopsy cases that where the fluid was not shown upon the X-ray, the clinician had also failed to predict the presence of fluid at autopsy. Since cases are examined rather carefully when they are considered terminal, in order to determine at least the important pathologic processes present, the question of failure to ascertain the presence of fluid again suggested the question of fluid distribution.

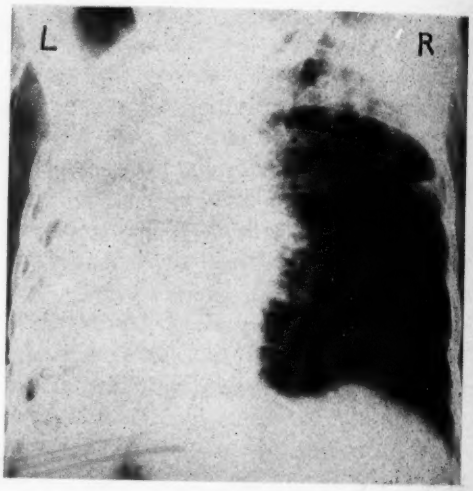


Fig. 1. Postmortem upright film of tuberculous chest that had 100 c.c. of fluid in the left pleural cavity and 1,080 c.c. in the right.

It is the clinical policy to withdraw a specimen of pleural fluid to confirm its presence, and for guinea pig inoculation, when a diagnosis of effusion is made physically or roentgenographically. Now, is it possible that certain pleural effusions are present in cases under observation which have not been demonstrated by physical signs or by the routine X-ray plate? Conclusions drawn from numerous cases seen at autopsy where both methods have failed to detect the presence of fluid would indicate that this is quite possible.

[1]Read before the Denver Sanatorium Association, February 27, 1931.
Published with the consent of the Surgeon General of the Army, who assumes no responsibility for any statements contained therein.

Let us now consider what makes the X-ray diagnosis of fluid possible and the factors determining the shadows of pleural effusion. Effusions may be free or encapsulated. It is only free fluid without pleural adhesions that casts a typical shadow and our interest at this time is with the formation of the typical shadow and with the question as to whether it is possible by radiography to estimate the amount of free fluid in the chest.

The roentgen features of pleural effusions are determined, first, by the great absorptive power of fluid for the roentgen ray, which causes it to cast a dense, homogeneous shadow obscuring the lung beneath it, and secondly, by the elasticity and movement of the lung which is responsible for the unique configuration of the shadow. This is best seen in non-purulent effusion, where no adhesions exist. Free effusions are usually the result of transudates, tuberculosis, or malignancy. Blood will also remain fluid in the thorax. The slowly accumulating transudates offer the best opportunity for observing the changing configuration of the fluid shadow. The first evidence of fluid is always seen at the base, where the costophrenic sinus becomes obscured by the fluid shadow. The upper border is concave and, as the fluid increases, the shadow rises in the axilla and slopes toward the diaphragm. The upper border is clear, with small effusions. As the fluid increases the lung becomes compressed and more opaque and the fluid tends to spread over the lung so that the upper border is poorly seen. The diaphragm shadow is lost when there is enough fluid to cover it, due to the similar density of fluid and soft tissue, and the shadow is continuous with that of the liver or spleen.

It seems probable that the elasticity and capillary action of the pleuræ cause the fluid to spread in a thin layer over the entire lung, but the configuration of an effusion is due to the pull between gravity and the elastic tension of the lung. The former causes the effusion to gravitate to the base of the chest; the latter, as the lung is separated from the chest wall, exerts a pull on the surface of the fluid, which is greatest near the lower axilla, drawing the fluid upward. The effusion therefore rises obliquely from the midline, reaching its highest point in the axilla, thence descending toward the spine, once more obliquely. The characteristic formation is due to the attachment of the lung in the hilus and its lessened mobility in that area. The outer margin of the lung, being lighter, more compressible, and freely movable, is floated upward by the increased fluid, producing the curved upper border. The narrow ribbon-like shadow at the lateral chest wall is due to the fluid being sucked up by the capillary action of the two approximated layers of pleura. This action must overcome the cohesive force that binds the two moist surfaces together and is not operative in the cadaver. The last place to lose its aëration is the medial margin of the apex.

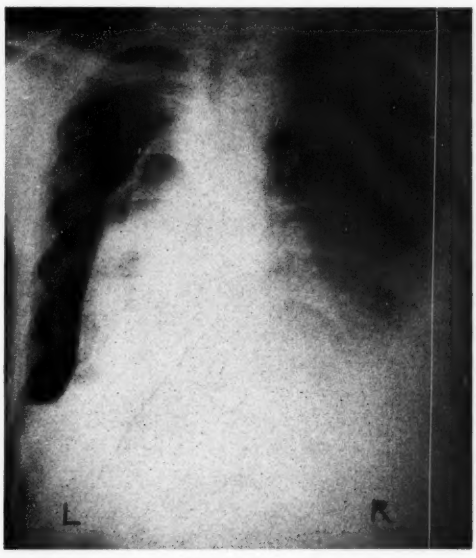


Fig 2. Effusion showing usual curved upper border on right. Pneumothorax with straight fluid level on left.

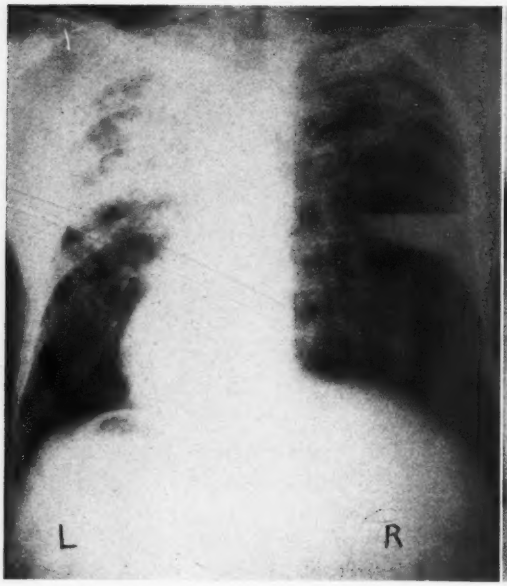


Fig. 3. Circumscribed spontaneous pneumothorax pocket with fluid level.

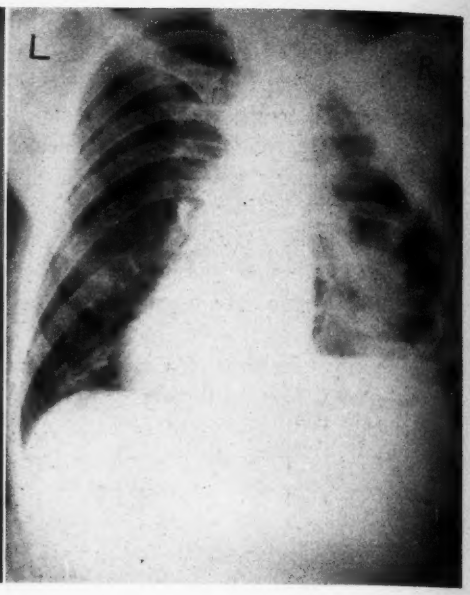


Fig. 4. Thoracoplasty, right, with pneumothorax and multiple fluid levels due to pocketing.

Emerson (1) in his "Physical Diagnosis" says:

So long as Ellis' S-curve can be made out the elasticity of the lung is not exhausted but governs the shape of the surface of the underlying fluid; and so long as this is the case, diminution of the volume of the lung has been due not to compression but purely to retraction. Unless the chest is over half full, the entire mass of fluid and to some degree the diaphragm below, are held up against gravity by the superior force of the elastic recoil of the lung. The negative pull is such that air will be sucked in through an open needle through the fluid.

That the roentgen shadow is a concave oblique line running upward toward the axillary border of the chest and not the S or parabolic curve mapped out on physical examination, Schill (2) demonstrated, was due to the fact that only the inner side of the parabola casts the shadow on the roentgenograph.

As the quantity increases, the weight of the fluid usually displaces the heart and mediastinum when the latter is not fibrosed and fixed, and may cause widening and bulging of the intercostal spaces. With consolidated or fibrosed lungs, the lungs are heavier and do not float upwards. The shadow is more likely to be a ribbon along the periphery, provided there are no adhesions. Negative pressure has nothing to do with the configuration of the fluid. When pneumothorax is present, there is no capillary attraction and the fluid all collects in the base with the usual fluid level.

Effusions due to pyogenic infections are likely to result in pleural adhesions and pocketing or encapsulation, and no study of these has been attempted at this time.

In our study of pleural effusion, we have sought primarily to determine the minimum

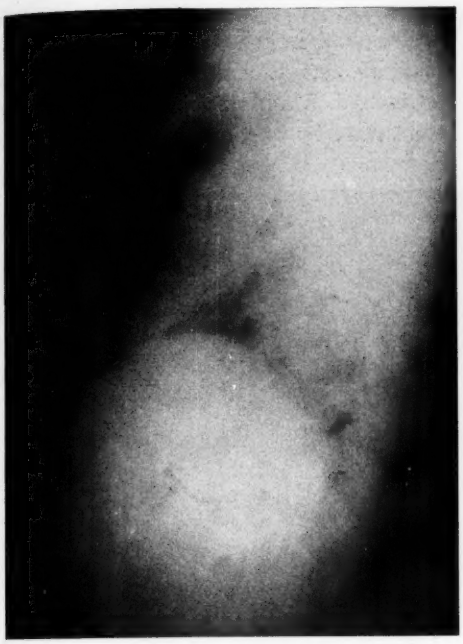


Fig. 5. Lateral chest, with small effusion seen in anterior sulcus.

amount of fluid which is necessary to cast a shadow over the lung or blur the costophrenic sinus.

Dr. F. Fleischner (3), roentgenologist at the Wilhelminenspital, Vienna, teaches that 400 c.c. of fluid can be present in the pleural cavity without collecting in the complemental spaces and be easily overlooked on X-ray films. He states that this fluid spreads out by capillary attraction in a thin film over the entire lung. It may be demonstrated in X-ray films as a linear shadow along the lateral margin of the lung, differentiated from thickened pleura by the fact that at the end of expiration this line becomes broader. Dr. Fleischner also claims that a pleural effusion covers the lung at the same level, front, back, and laterally. In front and behind, it is less in amount than laterally; also that in all pleural effusions, regardless of the amount, a thin film of fluid covers the entire lung by capillary attraction.

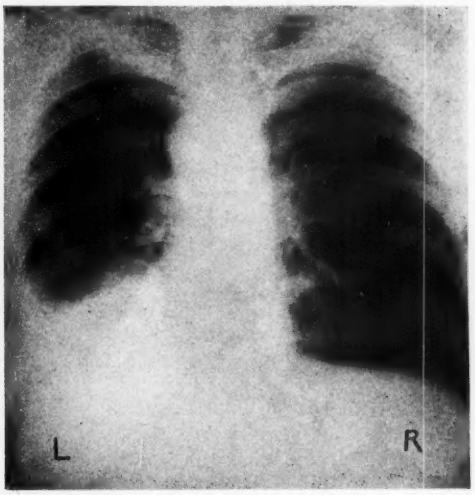


Fig. 6-*A*. Effusion, left thorax, upright postero-anterior position.

It has been estimated by Emerson that it is almost impossible by physical diagnosis to detect a pleural effusion of less than 250 c.c. and usually less than 400 c.c. cannot be diagnosed.

Ganter (4) believes that less than 400 c.c. of fluid in the pleural cavity can hardly be diagnosed by the usual methods of roentgen examination. Before usual X-ray signs are present, there must be a filling of the posterior and frequently also of the anterior pleural sinus, which lies below the dome of the diaphragm.

Numerous positions have been tried besides the usual postero-anterior. The lateral chest sometimes gives information as to effusion. Various positions in front of the fluoroscope have been tried and useful information is sometimes obtained.

Correra (5) in a roentgen study of the pleura with what he terms "cranio-dorsoventral projection of the thorax" showed that when there is an effusion at the base, the pleural fluid reaches a considerable height and in some cases even covers the apex of the lung. We have not used this position.

If fluid can be moved above the shadow

of the diaphragm by changing position of the patient, it should be more easily demonstrated.

A study of the literature reveals great confusion of opinion. Cabot (6), Emerson (7), Bigler (8), and Sante (9) state rather definitely that effusions change little with change of position. Lenk (10) quotes Continental authorities to the same effect, but from his own observations concludes that both exudates and transudates are freely movable. While Wessler and Jaches (11) state:

When the patient is recumbent, the fluid flows upward to the apex so that the pulmonary field is entirely obscured and the level of the fluid disappears. On the screen the movement of the fluid level may be seen as the patient's chest is tilted to the side, unless there is air in the pleural cavity. This shift in the fluid level is a slow, almost imperceptible one. It is best seen with effusions of moderate size. When the chest is almost full of fluid or in the presence of adhesions on the pleura, it may be absent.

Schiassi (12) in a study of distribution of the fluid in the pleural cavity, injected small amounts of lipiodol into recent, moderate-sized, serofibrinous effusions, and demonstrated by various positions the free displacement of this type of effusion as well as of transudates.

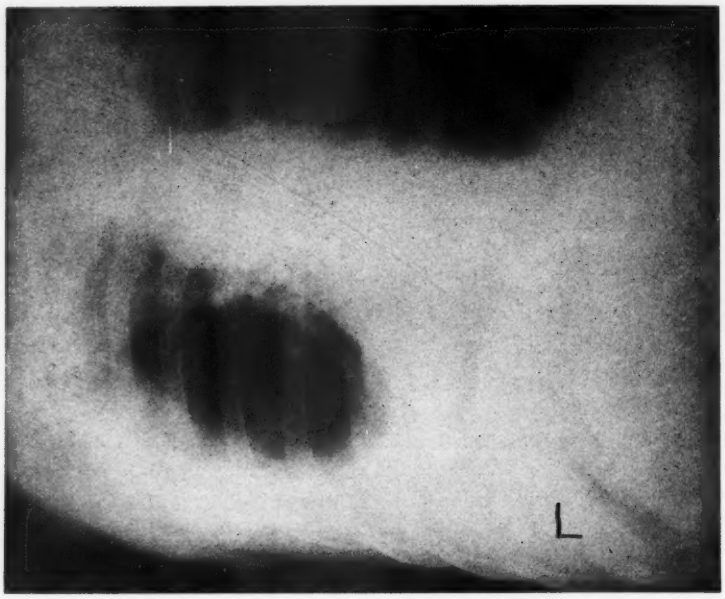


Fig. 6-*B*. Same in lateral decubitus position showing movement of fluid.

Sante says that the organs change their location and shape on change of position, and this accounts for the apparent difference in the outline of the fluid.

We have fluoroscoped patients and made films, standing and recumbent, which showed the fluid spreading over the anterior surface of the lung, after the patient has reclined.

Rigler (13) undertook a similar study at the University of Minnesota, presented at the Detroit meeting of the American Medical Association, and established movement in most cases of free fluid. He says:

In order to produce the change in the position of the fluid from the pleural sinus below the dome of the diaphragm to the

lateral portion of the pleural cavity, the lateral decubitus position is most advantageous.

He found that fluid was thus demonstrated when not seen in the upright position in several cases. This position also showed fluid entering the interlobar septum and appearing as a wedge-shaped shadow. It is useful to differentiate between fluid and thickened pleura as the latter does not change with change of position.

Sante, in his discussion of Dr. Rigler's paper (13), says that it has demonstrated to him the movability of fluid and he acknowledges a change of view.

The only previous references to this position found in the literature were Merlo Gomez and Heidenreich (14) in 1924, and Polgar (15) in 1926, who confirmed the free displacement of pleural effusions and demonstrated by screen and plate the advantages of examination of the patient lying on his side.

In his later paper, Rigler (16) seems to have settled conclusively the confusion regarding the movability of fluid, demonstrating beyond the shadow of a doubt, displacement in all positions.

On account of the confused findings of our postmortem films, we set out to determine whether it is possible by X-ray to estimate the amount of free fluid in the chest and how large an amount of it there must be in the thorax to cast a diagnostic shadow on the roentgenogram. Experience gained in the study of postmortem films and findings pointed against the success of such experiments and there was ample proof that the films often failed to disclose large pleural effusion when smaller effusions had been readily demonstrated by physical signs as well as upon the roentgenograms.

Since it had been observed repeatedly at autopsies that the postmortem films of the lungs made in the recumbent position, failed to show pleural effusions varying in amounts from 100 to 500 c.c., as a preliminary to

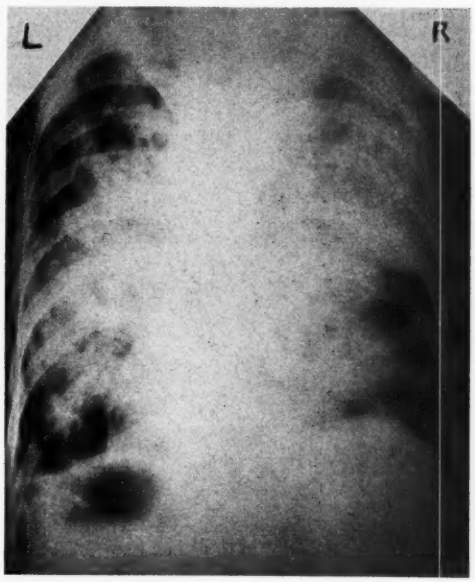


Fig. 7. Postmortem upright postero-anterior film; 25 c.c. of fluid in left thorax, 400 c.c. in right.

further study of postmortem films, it was felt that they should be as nearly comparable to the stereo upright posterior anterior roentgenograms as possible. For this purpose, Colonel Bruns devised a suspension apparatus by which four-foot, upright exposures may be made and excellent films are now secured after the death of every patient. Detail is sufficiently clear so that small blurring of the costophrenic sinus may be detected. An estimate of the amount of fluid present in every suspicious case is made at the time of reading the postmortem film prior to the autopsy presentation. The pathologist carefully measures and records the amount of fluid present on each side at every postmortem examination. The amount of fluid actually found is checked against the estimated amount and the figures marked on the postmortem film to secure a more or less permanent record showing the amounts found on each side. Although this has now been done on over one hundred cases, it is still not possible to prognosticate fluid in every case from the films, nor has it been

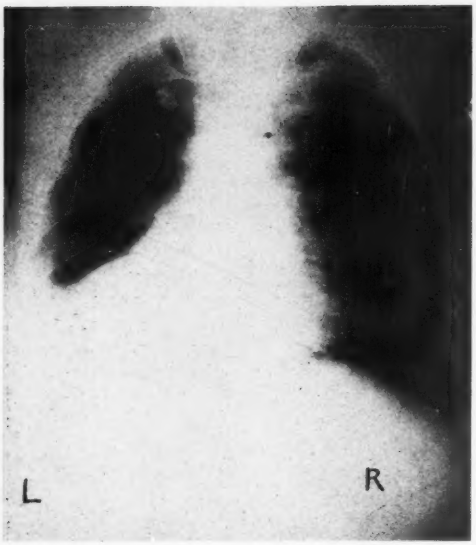


Fig. 8. Postmortem upright postero-anterior film; 900 c.c. of fluid in left thorax, 200 c.c. in right. Cardiac transudate.

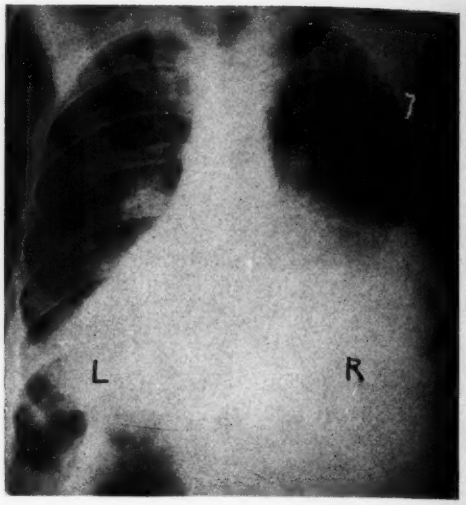


Fig. 9. Postmortem upright postero-anterior film, cardiac death; 175 c.c. in left thorax, 1,750 c.c. in right.

possible to work out any method of telling the exact amount of fluid when it is thought to be present. The elastic condition of the lung and its compressibility have a definite bearing on the appearance of the fluid. It rises much higher when the lung resists compression.

A series of experiments was performed on cadavers by injecting pleural fluid taken from patients in the wards into the pleural cavities of cadavers. Films were made following the injection of each 100 c.c. of fluid in the endeavor to discover when the fluid would begin to show. The initial pneumothorax needle was used and the injection made by officers skilled in pneumothorax work. Many difficulties were encountered. In spite of great care, pneumothorax was produced in many chests and caused the usual flat fluid shadow. It was also found next to impossible to separate the visceral and parietal pleuræ by fluid in cadavers where rigor mortis was present and the tissues chilled from refrigeration. In this hospital few patients die without pleurisy and adhesions, so that suitable material was difficult to secure. When fluid was successfully injected in suitable thoraces, there being no motion of the pleura and capillary attraction being *nil* in the opposed surfaces, the fluid remained where it was deposited and refused to assume the configuration of pleural effusion. We were finally forced to the conclusion that pleural effusion could not be induced in the dead body that would simulate the form of effusion seen in the living.

This threw our experiments back on spontaneous effusions. We have continued comparing postmortem films with autopsy findings of fluid for over a year, and have a hundred such cases. Many of the films from these cases are being shown and the confused findings are very evident.

We have also studied all of the available cases of free effusion in the wards during this time and have made films before and after paracentesis, comparing the appearance before and after withdrawing definite amounts. These changes have not been uniform and there is the difficulty arising from

not being able to measure the fluid still remaining after tapping. These ward cases have also had films made in various positions to show the change in appearance on change of position, and to demonstrate the value of the lateral decubitus position.

We are forced to the conclusion that fluid is missed at both physical examination and on the roentgenogram and fluoroscope because it is so situated as to be indiscernible. Now it must either be in the sulci at the base of the diaphragm as claimed by Emerson, Ganter, Rigler, and others, or evenly distributed over the surface of the lung in a thin layer, as Dr. Fleischner claims he has demonstrated. The proponents of both views claim that 400 c.c. may be present without being demonstrable. We see no reason why both phenomena may not occur but we believe that in certain cases much smaller amounts may be revealed.

The question why greater or lesser amounts may be hidden and why in some cases the fluid is all at the base and in others spread evenly over the lung, involves physical factors which we have not yet discovered. The degree of elasticity of the lung, the smoothness of the pleura and its capillarity, the specific gravity and viscosity of the fluid, all are factors involved, and the proper combination of these forces probably will produce any one of the forms which pleural effusion assumes.

I cannot conclude without an acknowledgment of thanks to Colonel Earl H. Bruns, M.C., Chief of the Medical Service, and Major W. C. Pollock, M.C., for many valuable suggestions and for advice and assistance in the preparation of this paper and the experiments incident thereto.

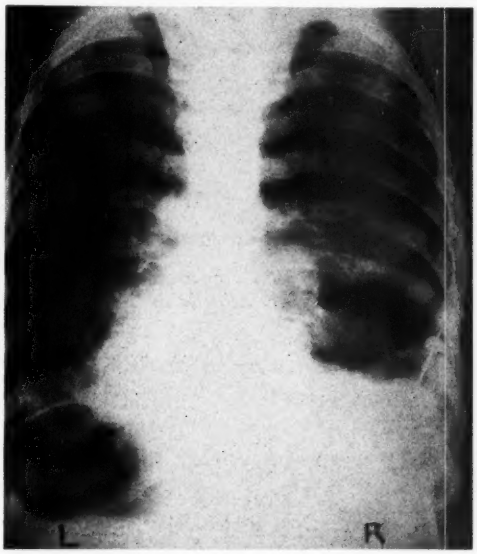


Fig. 10. Postmortem upright postero-anterior film; 600 c.c. of fluid injected into right base, seen as curved shadow resting on diaphragm at point of needle. Fluid fails to assume usual concave shadow.

SUMMARY

1. Postmortem chest films made on every deceased patient at Fitzsimons General Hospital show a wide variation in regard to the demonstration of pleural effusions.

2. A large series of films was checked against autopsy findings of pleural effusion. No correspondence between films and findings could be found.

3. Endeavor to produce typical pleural effusions in the cadaver was not successful, as the vital factors are necessary to produce the typical configuration.

4. While small effusions cannot be accurately estimated by radiography, it is believed that the method of making films of suspected cases in the lateral decubitus position is the best method of demonstrating small effusions.

5. The failure to find fairly large effusions (400–600 c.c.) in numerous cases either by physical diagnosis or by the roentgen examination, is due to the distribution of the fluid, which varies in different cases according to the combination of physical factors present.

REFERENCES

(1) Emerson, C. P.: Physical Diagnosis, 1928.
(2) Schill, I.: Beitr. z. Klin. d. Tuberk., 1927, LXV, 507.

(3) FLEISCHNER, F.: Lecture Notes by Col. E. H. Bruns, 1928.
(4) GANTER, G.: Deutsches Arch. f. klin. Med., 1922, CXLI, 68.
(5) CORRERA, T.: Radio. Med., 1927, XIV, 553.
(6) CABOT, RICHARD: Physical Diagnosis, 1927.
(7) EMERSON, C. P.: Tice's Practice of Medicine, 1924, V, 598.
(8) BIGLER, J. A.: Interpretation of Roentgenograms of the Chest in Children. Am. Jour. Dis. Child., January, 1930, XXXIX, 91-106.
(9) SANTE, L. R.: Roentgen-ray Diagnosis of Pleural Effusions. Jour. Am. Med. Assn., 1927, LXXXVIII, 215.
(10) LENK, R.: Wien. Arch. f. inn. Med., 1925, XI, 459.
(11) WESSLER and JACHES: Clinical Roentgenology of Diseases of the Chest. XV.—The Pleura, 1923.
(12) SCHIASSI, F.: Arch. di Pat. e Clin. Med., 1926, V, 1.
(13) RIGLER, L. G.: Roentgen Diagnosis of Small Pleural Effusions. Jour. Am. Med. Assn., Jan. 10, 1931, XCVI, 104.
(14) MERLO GOMEZ, J. F., and HEIDENREICH, A. J.: Rev. Assoc. Med. Argentine, 1924, XXXVII, 135.
(15) POLGAR, F.: Fortsch. a. d. Geb. d. Röntgenstrahl., 1926, XXXV, 618.
(16) RIGLER, L. G.: Roentgenologic Observations on the Movement of Pleural Effusions. Am. Jour. Roentgenol. and Rad. Ther., February, 1931, XXV, 220-230.

STUDY SHOWS SUNLIGHT INCREASES NUTRITION

TUCSON, ARIZONA.—Studies showing how sunlight increases the nutrition of the human body have just been reported by W. W. Lepeschkin, of the Desert Sanitorium and Institute of Research here.

Mr. Lepeschkin studied the action of sunlight on red blood cells. When these cells are suspended in a salt solution and exposed to direct sunlight, they gradually disintegrate and are destroyed. Their resistance to poisons is very much reduced. Only the visible rays of the sunlight reduce this resistance, however. Ultra-violet rays, if they are weak or act for a short time, increase the resistance of the red cells and protect them against the harmful effect of visible rays, Mr. Lepeschkin found.

Visible rays of sunlight affect red blood cells in another way Cells that have been exposed to this light are more permeable to water-soluble substances. Such irradiated corpuscles can take up increased quantities of sugar, the experiments showed.

"It may, therefore, be assumed that the nutrition of red cells is enhanced by sunlight," Mr. Lepeschkin concluded. "As the chemical and physical structure of red corpuscles is similar to that of colorless cells, the results obtained on red corpuscles can be extended to all cells of our organism, and it is likely that sunlight increases the nutrition of our organism in general."

—*Science Service.*

A LEAD-LINED SAFE FOR STORING LARGE AMOUNTS OF RADIUM[1]

By L. F. CURTISS, Bureau of Standards, WASHINGTON, D. C.

Abstract.—Recently there has been installed at the Bureau of Standards a safe designed and constructed by the makers for storing radium preparations. This safe is unusual in that it has an inner compartment 15×24×26 inches with walls of lead 6 inches thick, poured in one piece except for a door of the same thickness which forms one side. It is shown that such a safe provides ample protection from the radiation from 10 or more grams of radium. In addition, a description is given of the lead-screened compartments installed in the safe by the Bureau of Standards for protecting the operator from the radiation when the heavy lead door is opened for replacing or removing preparations. The complete unit makes possible the storage and handling of as much as 10 grams of radium without exposing the operator directly to the radiation of more than a single preparation at a time.

I.—INTRODUCTION

THE storage of preparations of radium presents two problems. Because of the large amount of money represented by even small preparations, it is necessary to protect them from theft and damage by fire. On the other hand, when more than a very few preparations of average size are accumulated in one place, the problem arises of protecting persons who handle or must be near them from the effects of the penetrating gamma-radiation. Although the best protection to the individual from the radiation is afforded by the inverse square law, so that, at even moderate distances, the intensity of the radiation is greatly reduced from that near the radium, it is not always possible to take advantage of this source of safety, particularly for those who must handle the preparations. It is, of course, comparatively easy to screen off the beta-radiation and the softer gamma-radiation by using comparatively thin sheets of lead; however, such screening reduces only slightly the intensity of the more penetrating gamma-rays. These rays have long been recognized as a source of potential danger to those exposed to them, the safe limit of exposure to such radiation never having been satisfactorily determined, to the knowledge of the author. However, recent experiments by Whitman and Tuve (1) have shown that in the case of rats the lethal dose of radiation is less than ten times the smallest dose which will affect the blood count. This indicates that observations made on blood do not constitute a safe index to the damage done by penetrating gamma-radiation. It thus appears that the best procedure is to reduce the exposure as far as practicable, since there appears to be no way to determine by a medical observation of the operator whether any harm is being done by the radiation until great damage has resulted. At least, when definite changes begin to appear in the blood count, irreparable damage may have already been done to the human system. The photographic method of determining the exposures, recommended by these investigators, seems to offer some promise of providing an indication of the dangers in a specific situation if the photographic tests are carefully made. Even then, the question of possible *cumulative* effects

[1]Publication approved by the Director of the Bureau of Standards of the U. S. Department of Commerce.

upon the human system by repeated exposures to small amounts of radiation are left out of consideration.

In view of these facts, it appears advisable to reduce to as small an amount as can be done with reasonable expense and effort, the exposure of persons who regularly work with radium. This involves the storage of the main bulk of the radium, accumulated in any one place of work, in some sort of lead-walled container which will reduce the intensity of even the most penetrating gamma-radiation outside the container to a small fraction of its initial intensity inside. This article describes, for the benefit of those who may be faced with the problem of storing considerable amounts of radium, how this problem has been met in the Radium Laboratory of the Bureau of Standards.

The Radium Laboratory has, as one of its principal activities, the testing of sealed preparations by the gamma-ray method for those purchasers of radium who request this service. Since it is quite impossible to tell the value of a preparation of radium without the equivalent of a gamma-ray standardization, which the average purchaser could not do without considerable expense and delay, it has naturally developed that a large part of the radium sold in this country passes through the Bureau of Standards for test. In addition to the more or less steady flow of small shipments, the Radium Laboratory receives at intervals single shipments of one or more *grams* of radium for measurement. On one recent occasion it received in one shipment five grams to be tested for a single purchaser. This situation makes it imperative that some suitable method of storage be available, since every preparation, to insure that it is in equilibrium, must remain at the Bureau at least six days, and this time of storage may be considerably extended as a result of forced delays in measurement when

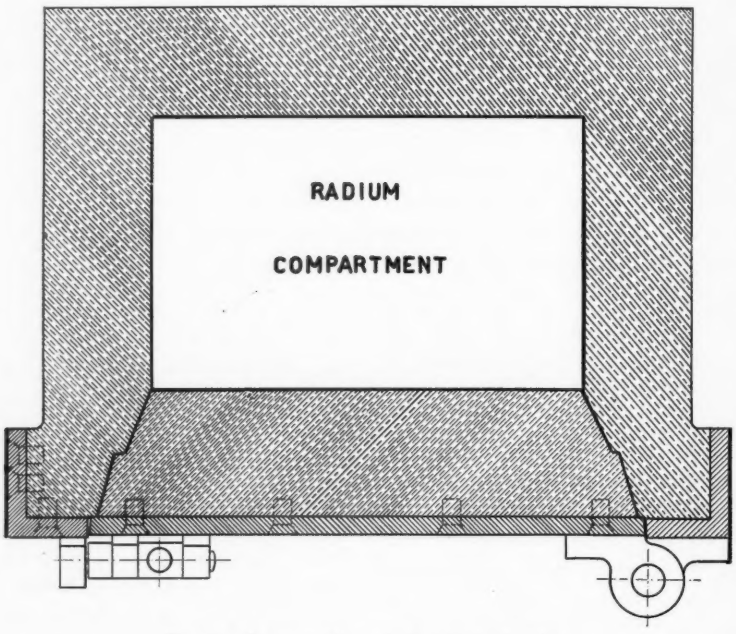


Fig. 1. Cross-section of the lead chamber.

preparations are coming in rapidly. Under these conditions as much as seven grams has accumulated in our laboratory.

The safe described was constructed for the Bureau of Standards by the makers from their own designs. Considerable credit is due them for the skillful way in which they worked out a problem somewhat unusual in safe-building. To the writer's knowledge it is the first safe of its kind to be manufactured.

II.—FACTORS CONSIDERED PRELIMINARY TO THE DESIGNING OF THE SAFE

In approaching this problem a number of details had first to be settled before any attempt at a design of safe could be made. The most fundamental, perhaps, was the amount of storage space required for the radium and its individual containers. From our experience with the amounts of radium which we had received in the past, with a reasonable allowance for large single shipments, we finally determined on a storage chamber 15 × 24 inches and 26 inches in height.

The next detail to be dealt with was the thickness of the lead walls of this storage chamber. Here, of course, many things were to be considered, such as expense, degree of screening desired, permissible weight, and amount of radium to be stored. Probably the first point to be settled was the degree of screening desirable. From the preceding discussion it can be seen that, if large quantities were to be stored—say, 7 grams—a much greater screening would be required than for small amounts. From the known absorption coefficient in lead for the hard gamma rays from RaC, $-\mu = 0.535$, it is easy to determine the absorption for various thicknesses of lead. For example, applying the usual absorption equation $I = I_o e^{-\mu x}$ to a layer of lead 6 inches, or 15 cm., thick, we see that I, the intensity outside a layer of lead of this thickness, is equal to 0.00043 I_o, where I_o is the intensity of the radiation inside that safe. In other words, if a container with walls of this thickness were used to store 10 grams, the radiation outside would be equivalent to that from 4.3 milligrams at the same distance. Since, in the construction of a safe, other metal parts must be used which will increase somewhat the screening effect of the whole safe, it was considered that 6 inches of solid lead was sufficient for the purpose. As will be seen, individual groups of preparations had to have their own lead screening, so that the total thickness of screening would be equivalent to about 7 inches of lead, if the walls of the lead chamber were made 6 inches thick.

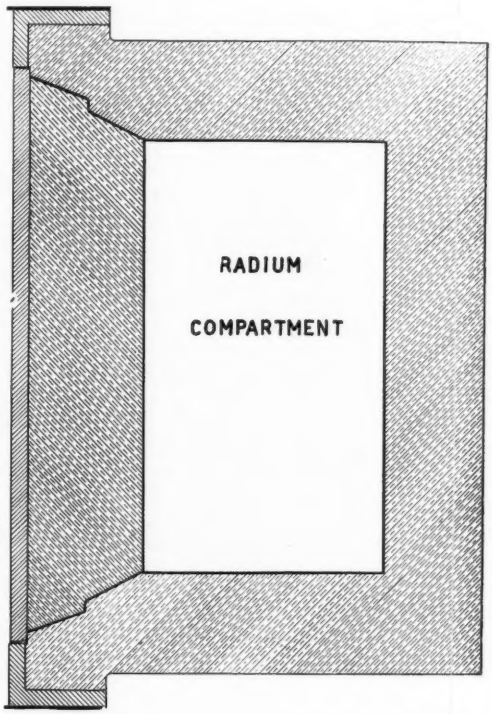


Fig. 2. Vertical cross-section of the lead chamber.

Having settled on these two details, the size of the interior of the inner lead cham-

ber and the thickness of the walls of this chamber, the problem of designing and constructing the safe itself was worked out by the builders. Their solution of this problem is discussed below.

ing this lead in the desired form largely to its purity. Of course, imperfections in the casting, such as blow holes, would greatly impair the efficiency of the safe.

In Figures 1 and 2 horizontal and vertical

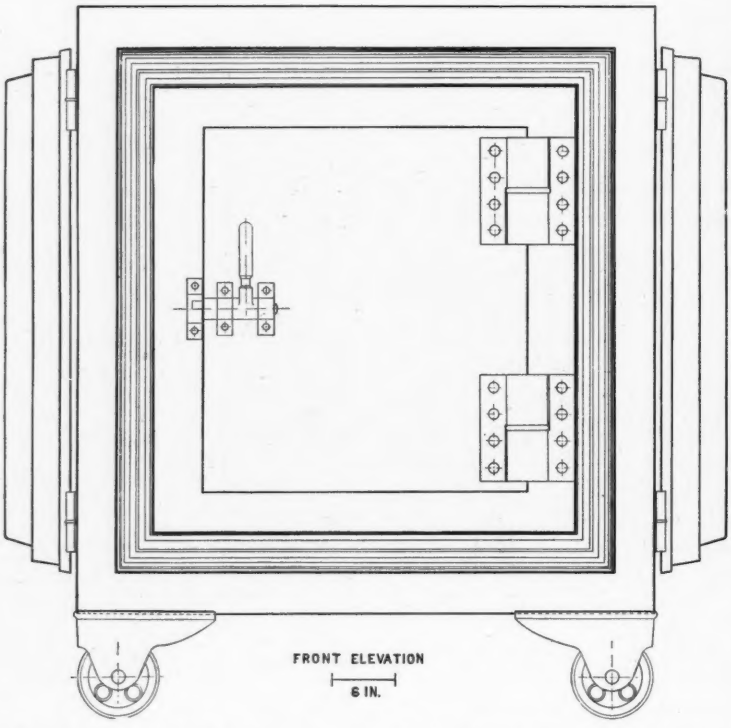


Fig. 3. Front view of the safe showing the lead doors closed, the insulated doors of the fireproof case standing open.

III.—DESCRIPTION OF RADIUM SAFE

The main feature which distinguishes it from all ordinary safes is the inner lead chamber with lead walls 6 inches thick. This lead chest was poured in one piece of solid lead and is open on one side to receive a door of lead of the same thickness. Some idea of the weight involved can be derived from the fact that the door alone weighs approximately 2,700 pounds. In preparing for the construction, the manufacturers sought for the purest lead obtainable—99.9 per cent—and attribute their success in cast-

cross-sections of the lead chamber of the safe are shown. The heavily shaded parts are the walls of the lead chamber. This view indicates clearly the method of dovetailing the door and the opening to receive it so that there can be no chance of the radiation escaping between the door and its frame without passing through a considerable thickness of lead when the door is closed. The door is hung on two large ball-bearing hinges, which are supported on a heavy steel frame fastened to the lead chamber. These hinges carry a one-inch steel

plate on which the lead door is mounted. The lead chamber is anchored in a thick layer of the best quality insulating material (not shown), rendering the safe, in the usual sense, fireproof. This anchoring had to be carefully done so that, in the event of a fire, if the safe fell through a floor, the lead chamber would not break through its casing, with disastrous results to the chamber and its contents. The front of the fireproof case is closed by a pair of insulated doors, which are secured by bolts and a combination. These doors are shown (open) in Figure 3, which is a front view of the safe showing the lead door closed. Figure 4 is a photograph showing the same view of the safe, and Figure 5 is a photograph showing the lead door open. The safe weighs 20,282 pounds, exclusive of inner compartments in which the radium is stored, and is 67 inches high, 57 inches wide, and 41 inches from front to back when closed.

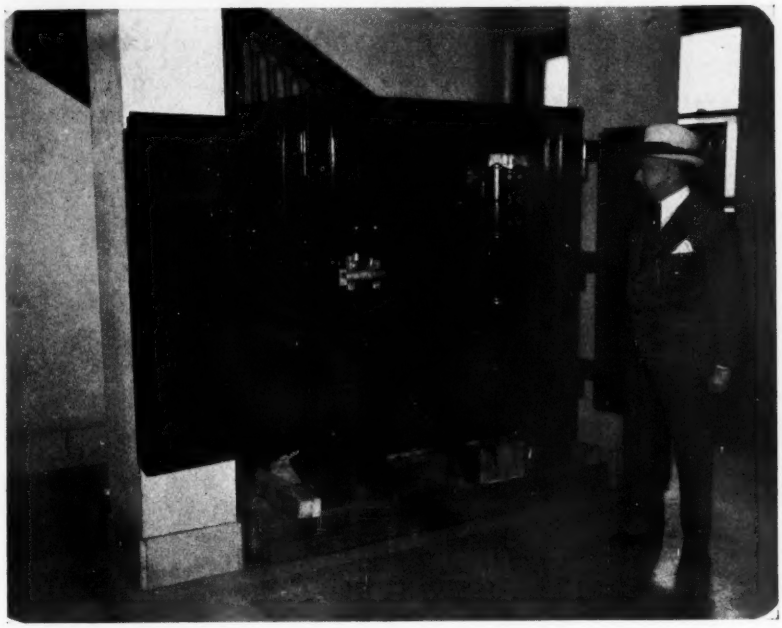


Fig. 4. Appearance of the safe, its relative size being indicated by the figure of the man on the right.

IV.—INNER COMPARTMENTS FOR STORING RADIUM

The safe as described above gives ample protection to the radium worker as long as the lead door is kept closed. However, when this door is opened for removing or replacing preparations, the operator is exposed to the full strength of the radiation. Even though this is a relatively infrequent operation, lasting for a few minutes at most, it may well prove a source of great danger when several grams of radium are stored in the safe. Consequently, after the safe was installed at the Bureau, the further problem arose of how to protect the operator when the lead door of the safe is open.

To this problem is added the requirement

Fig. 5. The safe, with the lead door open.

of providing small containers, each furnished with a certain amount of lead shielding, in which a few preparations can be stored and removed from the safe while still remaining in this screened container. The operator will then be exposed directly at any one time to the contents of one box. This exposure occurs during the brief interval that the cover is lifted from the box to remove a preparation for measurement. Thus the operator is exposed only to the radiation from a single unscreened preparation for any considerable time.

The arrangement which was finally worked out to meet these demands is illustrated in the drawing shown in Figure 6. It consists of a structure built up of ¼-inch cold-rolled steel which supports four sets of slides, each carrying three boxes for containing radium preparations. The boxes rest on two iron rails, *F F* (top view), which are bolted to plates, *P P*, at each end to form a rigid frame which slides alongside the two fixed guides, *G G*, which form a part of the main structure. When the frame of which *F F* is a part is drawn out, the boxes, held from sliding on *F F* by pins, are pulled out as shown in the second compartment from the top in the side view. Thus any or all of the boxes may be readily removed. The radium preparations are stored in the inner lead compartment, as shown in the top view. The boxes have a wooden case around the lead compartment to protect the hands

of the operator from beta-radiation while handling the boxes. This is clearly shown for the lower right-hand box in the side view, where the heavily shaded portion is the lead container, and the lighter portion the frame and cannot be drawn forward beyond the position shown in the second compartment from the top in the side view.

The chief feature of this arrangement, from the point of view of protecting the

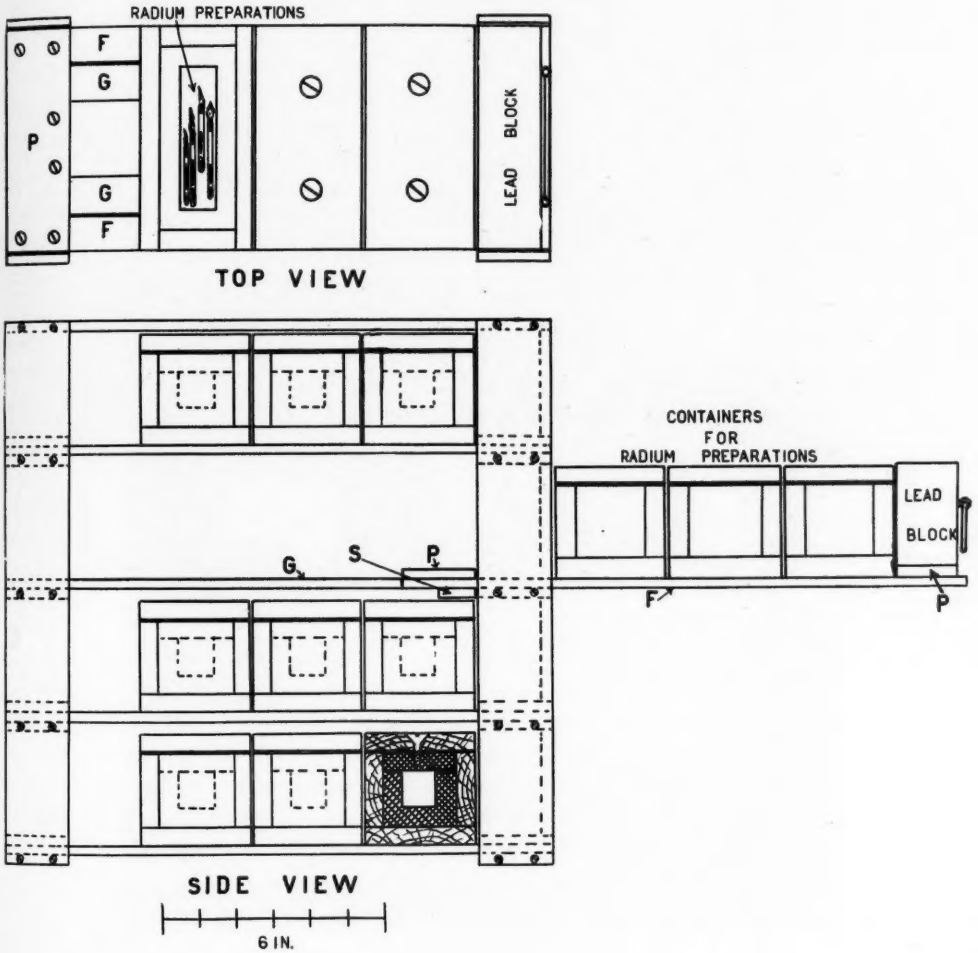


Fig. 6. Schematic drawing of the interior arrangement of the safe.

wooden case. To prevent pulling the frame entirely out and to keep it horizontal at all times, a piece, *S* (side view), is fastened underneath the pieces, *F F*, and extending under the fixed guides, *G G*, so that the frame cannot tilt at any position of the operator while removing radium from the safe, is the lead block which is mounted on the front end of each frame carrying the radium containers. This block, which is two inches thick, fills the opening into which the containers slide when the frame has been

pushed entirely into its compartment. Thus when all compartments are closed the operator is screened by a two-inch wall of lead. This is the situation when the large lead door of the safe is opened. One or more boxes can be removed from any compartment without removing this two-inch lead screen from any of the other compartments. Naturally it is of advantage to have the time of removing and returning boxes to the safe as short as possible. This is provided for by a number on each compartment and by giving each box, in addition, a distinguishing letter. Then, from records made at the time the radium is first unpacked, it is possible to locate at a glance any box containing the preparations desired and to remove the box without delaying to read the labels, etc.

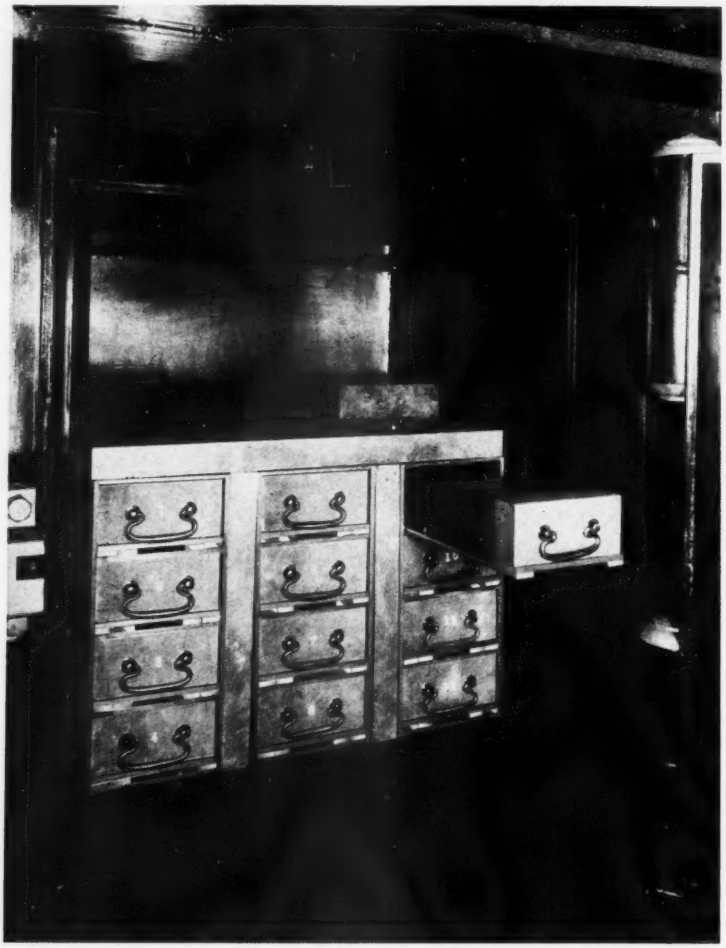


Fig. 7. The sections installed in the safe and the positions of the lead partitions, one frame being pulled out to show the arrangement.

It is obvious that any number of sections, such as are described above, may be placed side by side to provide for additional stor-

age capacity up to the limit of the safe. When this is done it is desirable to separate the sections by heavy lead partitions. The dimensions of the sections shown in Figure 6 were selected to permit three such sections being installed in the radium safe, making allowance for two lead partitions, one and one-half inch, separating them. Likewise, if the sections do not extend entirely to the top of the safe, a heavy lead partition should cover them.

The photograph shown in Figure 7 shows how these sections were installed in the safe and the positions of the lead partitions. One frame is shown pulled out for removing boxes. Frequently radium preparations are received by the Radium Laboratory at the Bureau of Standards which are not of the more usual form—tubes or needles. Among these are plaques, and preparations or remains of preparations which have been damaged. These are relatively few in number and are stored in special containers in the upper, undivided portion of the safe.

After the safe was installed, and while it contained 7 grams of radium, tests were made with an electroscope to determine the efficiency of the safe in screening the radiation. These tests showed that about 1 part in 70,000 of the radiation passed through the walls of the safe. In other words, the radiation was barely detectable by ordinary methods. Under these circumstances it would be practically impossible to suffer a dangerous exposure from the contents of the safe when in its neighborhood, even if it contained as much as 20 grams of radium, which is more than has been permanently accumulated in any one place in the world. The largest permanent collection of radium in this country at the present time amounts to about 8 grams.

REFERENCE

(1) WHITMAN, W. G., and TUVE, M. A.: Phys. Rev., 1931, XXXVII, 330.

THE EFFECT OF EXPERIMENTAL CHOLECYSTITIS ON THE CONCENTRATING FUNCTION OF THE GALL BLADDER[1]

By LEO DARNBACHER[2] and JACOB SACKS

From the Department of Physiology and Pharmacology, Northwestern University Medical School, CHICAGO, ILLINOIS

THE development of the Graham-Cole method of gall-bladder visualization has furnished a convenient means of estimating the ability of the gall bladder to concentrate bile, and thus permits a study of the effect of various experimental procedures on this function of the organ.

It was felt that an experimental study of gall-bladder injury might throw some light on the reasons for the disagreement between the X-ray and pathologic findings in non-calculous cholecystitis. Case (3) states that this type of lesion can be found by cholecystography in 93 per cent of cases, while Chandler and Newell (4) report an error of 36 per cent in the results of cholecystography in stone-free cholecystitis cases. The latter conclude that a normal cholecystogram does not necessarily mean a normal gall bladder, and that failure to obtain visualization may occur with nearly normal mucosa.

In the present work the gall bladder was injured by three different methods and its ability to concentrate studied, both at the time of the acute insult and during the progress toward healing or chronicity. The lesions were produced by: *(a)* X-ray irradiation of the gall bladder, as described by Brams and Darnbacher (2); *(b)* intravenous injection of Dakin's solution, according to the method of Mann (6), and *(c)* the injection of a mustard oil emulsion into the lumen of the gall bladder. The details are given below. The work was done on dogs.

EXPERIMENTAL

In order to minimize adventitious factors a constant routine was followed: the dogs were on the stock laboratory diet of bread, corn meal mush, and milk. Food and water were withheld the day of the dye injections. These were made between 7 and 8 P.M. and the cholecystograms taken between 9 and 10 the following morning, thus allowing a period of fourteen hours for concentration of the dye. The dose of sodium tetraiodophenolphthalein used was 0.18 gm. per kilo body weight. This was found to give satisfactory shadows in the control films and not to be toxic. The dogs ranged from 8 to 20 kg. in weight.

All animals were necropsied within fifteen minutes after the last cholecystogram. The bile present in the gall bladder was aspirated and the organ mounted on celluloid and placed in formalin immediately. Wherever it was feasible, the specific gravity of the bile was determined by pyknometer.

X-ray Cholecystitis.—The animals were fixed in the supine position and the gall bladder area exposed to two hours cross-fire irradiation as described by Brams and Darnbacher (2). Twelve days after the irradiation, cholecystograms were made. Five dogs were brought to necropsy at once, and five others kept for three months, during which period cholecystograms were made periodically. The animals were brought to necropsy at the end of this period.

Dakin's Solution Cholecystitis.—The technic described by Mann (6) was used. It was felt that the efficacy of the method was too well established to require checking.

[1]The material presented here is taken from a thesis submitted by Leo Darnbacher in partial fulfillment of the requirements for the degree of Master of Science.

[2]Deceased Sept. 12, 1930.

However, three dogs were killed within the second twenty-four hours after the injection of Dakin's solution. All three showed hemorrhagic cholecystitis; in two it was quite marked. The injury seemed to be limited to the gall bladder and cystic duct, the hepatic and common ducts not being involved. The remaining five dogs were allowed to survive for three months, during which period cholecystograms were made at intervals of two weeks.

Mustard Oil Cholecystitis.—Under ether anesthesia and aseptic precautions, the gall bladder was exposed by a right rectus incision. The fundus was picked up by an Allis forceps, the contents aspirated, and a suspension of mustard oil in water (0.5 per cent or 1.0 per cent) was injected. The volume of oil suspension used was somewhat less than that of bile aspirated. Finger pressure on the cystic duct prevented the passage of the irritating solution into the common duct. After from 30 to 60 seconds, the suspension was aspirated and that portion of the fundus which had been traumatized by the forceps and needle was tied off. The incision was closed in layers. Cholecystograms were made on the second or third day after the operation. One set of dogs was killed at this time; the others, as in the previous series, studied over a period of three months. As a control on the effects of the operative procedure, sham operations were done on two dogs. Instead of the mustard oil, normal saline was injected into the lumen of the gall bladder. In both dogs, the cholecystogram made three days after the operation was as good as the pre-operative one.

RESULTS

X-ray Cholecystitis: I. Acute.—Three animals showed gross evidence of injury to the gall bladder. Two of these gave good shadows, the third failed to give one. Microscopically, these gall bladders showed a general inflammatory reaction consisting of hemorrhage into the submucosa and muscularis and marked lymphocytic infiltration of the mucosa. There was some desquamation of the epithelium.

II. Chronic.—Five dogs were used: four gave good shadows and one a faint shadow twelve days after the irradiation. The next two or three films, *i.e.*, those made four to eight weeks after the irradiation, showed progressive diminution in shadow density. Then, in four of the dogs, the situation changed. The cholecystograms made ten and twelve weeks after the irradiation showed practically as good shadows as the control films on the same animals. The fifth dog did not show this recovery of function, and at necropsy a large, distended gall bladder was found, which contained watery fluid—a typical "hydrops" gall bladder.

The specific gravity of the bile from the four dogs ranged from 1.052 to 1.067, within the normal limits. Microscopically the gall bladders of the four dogs showed the following pictures: *(a)* epithelial hyperplasia with obliteration of the rugæ; *(b)* numerous nodules of dense infiltration of lymphocytes into the mucosa; *(c)* the fibers of the muscularis were disordered and interspersed with numerous strands of fibrous tissue.

Dakin Solution Cholecystitis.—The findings were consistent on the first cholecystogram only. In every case, the acutely inflamed gall bladder gave a good shadow. However, as the lesions were allowed to progress, some diminution in shadow density was noted in four of the five animals. The last cholecystograms, made three months after the acute injury, showed two good shadows, one fair, and two practically absent. The specific gravity of the bile also varied. That from the three which gave shadows had specific gravities of 1.045, 1.054, and 1.056. The other two biles had specific gravities of 1.036 and 1.029.

The pathologic picture in the acute stage consists of edema and hemorrhage in the subserosa, muscularis, and submucosa, with

some polymorphonuclear infiltration. In the chronic stage, the picture consists of hyperplasia of the mucous glands and cyst formation of the crypts. There is also some fibrosis of the subserosa and granules of brown pigment within phagocytic cells in this layer. There is little difference in the microscopic appearance of those gall bladders which concentrated well and those which gave poor shadows.

Mustard Oil Cholecystitis: I. Acute.—Seven animals were used: of these, two gave good shadows; the other five gave practically no shadow. In these five, the microscopic picture consisted of marked edema of the mucosa and submucosa, with pyknosis of the nuclei of the epithelial cells. There was some sloughing of the cuticular cap of the epithelial cells.

II. Chronic.—Of seven dogs that were carried for three months, five showed no shadow at the time of the acute insult. In these, the shadow remained faint or was absent for from four to six weeks, after which there was a return to normal shadow density. The density of the bile obtained at necropsy ranged from 1.055 to 1.065.

Microscopically these gall bladders showed epithelial hyperplasia, with small mucous cysts. There was also moderate to marked lymphocytic infiltration in the subepithelial tissue.

DISCUSSION

In general, the density of the shadow obtained on cholecystography was found to parallel specific gravity of the bile obtained at necropsy; hence the Graham-Cole test can be considered an index of the ability of the gall bladder to concentrate bile. The relation between the cholecystograms and the pathologic changes is not so well defined, and seems to depend on the character, extent, and location of the lesion. Obviously, if only a small area of the mucosa is injured, then the remaining intact epithelium will be able to function so satisfactorily that functional tests cannot be expected to show any abnormality.

In the case of Dakin's solution cholecystitis, in which the principal pathologic findings are in the subserosa, the ability of the vesicle to concentrate bile at the time of the acute insult is apparently not affected. In the acute lesions produced by mustard oil, in which the epithelium is affected, the power of concentrating bile is lost. In the acute lesions produced by X-ray irradiation, in which no layer of the gall-bladder wall escapes, the injury to the epithelium is apparently not severe enough to destroy function.

In the animals which were allowed to go on for three months, there is even less consistency in the results. True, the mustard oil series showed a recovery of function, but in the other two series the results were variable.

The X-ray series showed, as might be expected from the known effects of X-ray on living tissues, lesions which were slow to develop to their maximum intensity, and slow to heal. Even though the maximum anatomic damage was present from twelve to fourteen days after the irradiation, the cells were capable of function at this time. However, as time went on, the functional capacity of the cells decreased, so that at from four to eight weeks after the maximum anatomic damage the function was reduced to the point of failure of concentration. Then the reparative process began, and in three months from the time of the irradiation there was good function again.

The Dakin's solution series presents a somewhat similar picture. As in the X-ray series, the chief anatomic damage is to the deep layers of the gall-bladder wall. At the time of the acute insult, when the anatomic damage is greatest, there is no impairment of function. Later on, also as in the X-ray series, there is progressive loss of ability to concentrate. Unlike the other series, how-

ever, the injury is so severe in the majority of cases that return to a functional condition does not take place. The explanation of why the same degree of injury should produce temporary derangement in some cases and permanent loss of function in others, is beyond the scope of this paper.

If it is permissible to draw analogies between these experimentally produced cholecystitides and those met with clinically, we can say that the type of injury produced by mustard oil is similar to that seen as a result of infection ascending from the duodenum or descending from the liver. Graham (5) states that this is rare, but Birch-Hirshfeld (1) and Meyer, Nielson, and Fensier (7) hold that it is more prevalent than commonly supposed. The Dakin's solution and X-ray cholecystitis may be considered as analogous to the more usual type of acute cholecystitis, which is either lymphogenous or hematogenous in origin, and which attacks the deeper layers of the gall-bladder wall, leaving the epithelium practically unaffected.

CONCLUSIONS

1. Acute experimental cholecystitis may or may not inhibit the concentrating ability of the gall bladder; whether or not it does, depends on the nature, extent, and location of the pathologic changes produced.

2. Acute experimental cholecystitis due to direct chemical irritation of the gall-bladder mucosa causes a loss of concentrating ability from which recovery takes place in a relatively short time.

3. Acute experimental cholecystitis due to inflammation of the deeper layers of the gall-bladder wall causes no immediate decrease of function; later a decrease may appear from which recovery does not always take place.

4. The Graham-Cole test is an accurate index of the ability of the gall bladder to concentrate bile, but is not necessarily an index to the pathologic changes which may be present.

BIBLIOGRAPHY

(1) Birch-Hirshfeld: Lehrbuch der path. Anatomie, 4th Edition, 1895, p. 694.
(2) Brams, Julius, and Darnbacher, L.: Radiology, August, 1929, XIII, 103.
(3) Case, J. T.: Jour. Am. Med. Assn., Jan. 26, 1929, XCII, 291-297.
(4) Chandler, L. R., and Newell, R. R.: Jour. Am. Med. Assn., 1927, LXXXVIII, 1550.
(5) Graham, E. A., Cole, W. H., Copher, G. H., and Moore, S.: Diseases of the Gall Bladder and Bile Ducts, 1928, p. 116.
(6) Mann, F. C.: Ann. Surg., 1921, LXXIII, 54.
(7) Meyer, K. F., Nielson, N. M., and Fensier, M. L.: Jour. Inf. Dis., 1921, XXVIII, 456.

X-RAY PROTECTION[1]

Received for publication from LAURISTON S. TAYLOR, Chairman Advisory Committee on X-ray and Radium Protection

Preface.—Upon the suggestion of the secretaries of the International Safety Committee, Dr. G. W. C. Kaye and Dr. Stanley Melville, the Advisory Committee on X-ray and Radium Protection was formed in the United States for the purpose of preparing a unified set of safety recommendations. In order to have a committee not too cumbersome and yet thoroughly representative of the several phases of the art, two members were appointed by each radiological society, two by the manufacturers of X-ray equipment, and one by the American Medical Association. The presidents of the radiological societies were each asked to appoint one physicist and one radiologist. The members representing the manufacturers were selected by the manufacturers through nomination and ballot.

The following members compose the Committee:

Lauriston S. Taylor, representing the International Safety Committee and National Bureau of Standards.

Henry K. Pancoast, M.D., University of Pennsylvania Hospital, and J. L. Weatherwax, M.A., Physicist, Philadelphia General Hospital, representing the American Roentgen Ray Society.

R. R. Newell, M.D., Stanford University Hospital, San Francisco, and G. Failla, D.Sc., Physicist, Memorial Hospital, New York, representing the Radiological Society of North America.

Francis Carter Wood, M.D., St. Luke's Hospital, New York, representing the American Medical Association.

W. D. Coolidge, Ph.D., Associate Director, Research Laboratory, General Electric Company, Schenectady, New York, and W. S. Werner, Secretary, Kelley-Koett Manufacturing Company, Covington, Kentucky, representing X-ray equipment manufacturers.

The Committee recognizes that future development of the art may require changes in these recommendations. Since the existence of the Committee is not permanent, it recommends that any future changes in these proposals be made by the National Bureau of Standards after consultation with proper and recognized committees.

The recommendations of the Committee follow.

I. PROTECTION FROM X-RAYS

1. General Recommendations

A. Definitions.—1.01. Throughout these recommendations the word "shall" is used to indicate necessary requirements, while the word "should" indicates advisory requirements to be applied when possible.

1.02. The "lead equivalent" of a protective material is defined as the thickness of lead which will have the same true absorption for a given X-ray beam as the protective material.

1.03. The "protection coefficient" of a protective material is the ratio of the thickness of lead to the thickness of the material which absorbs a given X-ray beam to the same extent.

1.04. In expressing the protection coefficient the X-ray voltage at which the measurement is made shall be given for all materials owing their high absorptive power to other than lead content. For determining the protection coefficient either a photo-

[1]This paper has been issued by the Bureau of Standards as Handbook No. 15. Reprinted by permission.

graphic substitution or ionization substitution method, which takes the true absorption into consideration, shall be used.

1.05. For the purpose of specifying high tension spark-over distances, the following table gives the approximate needle point spark gap distance for peak voltages up to 300 K.V. (760 mm. atmosphere pressure and 20° C.).

TABLE I

Kilovolts (peak)	Needle point gap cm.	inches
5	0.42	0.17
10	.85	.33
15	1.30	.51
20	1.75	.69
25	2.20	.87
30	2.69	1.06
35	3.20	1.26
40	3.81	1.50
45	4.49	1.77
50	5.20	2.05
60	6.81	2.68
70	8.81	3.47
80	11.1	4.36
90	13.3	5.23
100	15.5	6.10
110	17.7	6.96
120	19.8	7.81
130	22.0	8.65
140	24.1	9.48
150	26.1	10.3
160	28.1	11.1
170	30.1	11.9
180	32.0	12.6
190	33.9	13.3
200	35.7	14.0
210	37.6	14.8
220	39.5	15.5
230	41.4	16.3
240	43.3	17.0
250	45.2	17.8
300	54.7	21.6

1.06. The term "direct radiation" shall include all radiation other than the useful beam emanating from the X-ray tube anode or the inside of a tube or tube container. The "useful beam" of X-rays shall include that part of the radiation used in examination or treatment. The term "scattered radiation" shall refer to the secondary radiation from the patient and any parts of the room or apparatus.

B. Rooms for X-ray Apparatus.—1.07. X-ray and control rooms shall be so located as to avoid dampness and to provide ventilation and light. This requires that, in general, such rooms be on or above the ground floor. All rooms should be decorated in light colors.

1.08. Forced ventilation should be provided to remove nitrous gases and ozone from all rooms occupied by patients or operators. This ventilation should be such that fresh air enters the room at or near the floor, and that stale air is removed near the ceiling at the opposite side of the room.

1.09. Rooms containing high tension generators, all tube inclosures or other places where high tension is present shall be provided with suction ventilation to remove nitrous or other gases.

1.10. All X-ray rooms (except for dental radiography) or booths shall be lined throughout with sheet lead or equivalent material of assured quality, uniformity, and permanency, care being taken that there be complete overlapping of all joints. "Protective plasters" and lead rubber wall board are considered to be unsatisfactory for providing protection exceeding 1 mm. lead equivalent.

1.11. Protective lead coverings for X-ray rooms and booths shall not be perforated by nail holes, etc., unless such holes are adequately covered with lead.

1.12. Corner construction at the floor and ceiling of lead-protected rooms or booths shall provide at least the same degree of protection as the remainder of the walls.

1.13. The protective lead covering of any door leading to a treatment or examination room or booth shall overlap so as to adequately prevent the passage of X-rays.

1.14. The following lead equivalents are recommended as adequate:

TABLE II

X-rays generated by peak voltages not in excess of—(K.V.)	Minimum equivalent thickness of lead (mm.)
75	1.0
100	1.5
125	2.0
150	2.5
175	3.0
200	4.0
225	5.0
300	9.0
400	15.0
500	22.0
600	34.0
900	.....

C. Marking of Protective Devices.—1.15. All X-ray protective materials shall be indelibly marked by the manufacturer in such a manner as to readily show the lead equivalent thickness of the material. (See Table II.) For protective materials containing other than lead to cause the high absorption, the voltage at which the equivalence applies shall be given.

1.16. All X-ray tube inclosures made of lead glass, all metal shields, and oil-immersed X-ray tube containers shall be marked by the manufacturer in such a manner as to readily show the equivalent lead thickness of the protective material.

D. Tube Inclosures.—1.17. A protective inclosure shall surround all X-ray tubes so as to prevent the escape of direct radiation from the bulb and cathode and anode necks.

CLASSIFICATION OF X-RAY INSTALLATIONS

1.18. Class A. X-ray installations for diagnostic purposes at voltages up to 130 K.V. peak.

Class B. X-ray installations for superficial therapy at voltages up to 140 K.V. peak.

Class C. X-ray installations for voltages from 140 to 250 K.V. peak, in which the X-ray tube is housed in an inclosure affording the requisite protection from all direct radiation.

2. Special Requirements for Apparatus of Class A[2]

E. Protection from Direct Radiation.—2.01. A protective inclosure shall surround the X-ray tube bulb, and the arms for a distance of 4 inches from the bulb, so that direct radiation is shielded off in all directions. Open bowls shall not be used.

2.02. In the case of X-ray tubes having built-in protection, the equivalent lead thickness shall conform to Table II, and shall shield off all direct radiation.

F. Protection of Patient.—2.03. An aluminum filter, at least 0.5 mm. thick, shall be permanently mounted in all fluoroscopic and radiographic tube inclosures.

2.04. The diaphragm of the tube container shall have a permanent covering of asbestos board at least 0.5 mm. thick placed between the tube and filter next to the filter.

It is recommended that for prolonged fluoroscopic work an accumulative timing device be used which will either indicate or turn off the apparatus when the total exposure exceeds a certain previously determined limit—given in one or in a series of exposures—assuming the same body area exposed.

G. Protection of Physician and Personnel (Protection from Direct Radiation).—2.05. The fluorescent screen shall be covered with plate lead-glass having an equivalent lead thickness of at least 1.5 millimeters.

2.06. Protective gloves shall have an equivalent lead thickness of at least 0.5 mm., and shall insure protection to the whole hand—outer surface, palm, fingers, and wrist.

2.07. Protective aprons worn by the physician or technician shall have an equivalent lead thickness of at least 0.5 millimeter.

2.08. Aprons may be worn by the operator or may be permanently attached to the radioscopic apparatus in such a manner as to provide suitable protection.

[2]X-ray installations for diagnostic purposes at voltages up to 130 K.V. peak.

2.09. The tube protective inclosure shall be provided with an adjustable diaphragm which, when open to its fullest extent, leaves a margin of one-fourth inch of unilluminated fluorescent screen with the screen at its fullest distance from the tube. Diaphragm and screen should, when possible, be mounted on a common support so the two will always move together.

2.10. The fluorescent screen frame shall contain a protective material (1.5 mm. equivalent) overlapping the protective glass one-fourth inch and extending at least 6 inches beyond the edges of the glass.

Protection from Scattered Radiation.—2.11. To protect the physician from secondary radiation during fluoroscopic work, the following protective measures should be provided:

(a) Upright fluoroscope (standing or sitting patients).—Protective shield of at least 1.5 mm. lead equivalent, fastened to the fluoroscope and extending from one-fourth inch inside the border of the fluorescent screen to such a height above the floor that the physician's legs and body will be thoroughly shielded for all positions of the screen.

Wings of protective material (1.5 mm. equivalent) shall be provided to extend 6 inches to each side and top of the fluorescent screen and shall overlap the screen cover glass one-fourth inch. (See Sec. 2.07.)

(b) Horizontal fluoroscope.—Protective shields (1.5 mm. lead equivalent) shall be placed (rigid or movable), one on each side of the screen.

Shields of flexible material (1.5 mm. lead equivalent) should extend from the above-mentioned shields to the floor and should either move with the fluorescent screen and tube or cover the entire length of the table.

(c) Tilting fluoroscope.—Wherever practicable, the protective features of Sections *(a)* and *(b)* above should be followed out.

2.12. Radiographic and radioscopic rooms shall be lined throughout with at least 0.5 mm. of sheet lead or equivalent material of assured quality, uniformity, and permanency.

Exception.—This may be omitted only on outside walls and sides adjacent to unoccupied rooms.

2.13. To protect the operator and personnel, control apparatus for radiographic work should be in an adjacent room which provides protection equivalent to at least 0.5 mm. of lead. Control operators should be behind such protection during all radiographic exposures, and during all radioscopic work when practicable.

2.14. When it is impracticable to place the control apparatus in an adjacent room, as in Paragraph 2.13, it may be inclosed in a lead-lined booth within the radiographic room.

2.15. Either control room or booth shall be provided with a suitably large lead-glass window of 2.0 mm. lead equivalent.

2.16. The use of movable upright protective screens is dangerous and shall be discontinued.

2.17. When thermionic rectifiers are used they shall be either placed in a separate room or surrounded by material of 0.1 mm. lead equivalent.

3. Special Requirements for Apparatus of Class B[3]

H. Protection from Direct Radiation.—3.01. A protective inclosure shall surround the entire X-ray tube so that direct radiation is shielded off in all directions by protective material of 2.5 mm. lead equivalent.

3.02. This equivalent thickness may be reduced by an amount equal to the thickness of the lead lining of the room, except that in

[3]X-ray installations for superficial therapy at voltages up to 140 K.V. peak.

no case shall less than half of the lead protection be provided by the tube inclosure.

3.03. In the case of X-ray tubes having built-in protection or oil-immersed tubes in protective tanks, the protection shall be equivalent to that in Table II. Where the built-in protection is insufficient, additional protection in any direction shall be added up to the required amount.

3.04. When the X-ray tube is so arranged that the radiation can be taken off in only one fixed direction, a sheet of lead 2.5 mm. thick shall be placed in the path of the direct and useful beams, on the floor, wall, or ceiling opposite the diaphragm. This lead sheet shall extend 1 foot in all directions beyond the edge of the X-ray beam, determined by the largest possible aperture in the tube inclosure.

3.05. When the X-ray tube is so arranged that radiation can be taken off in several directions all parts of the room which may possibly be reached by the direct or useful beam of radiation shall be lined with sheet lead 2.5 mm. thick. The lead lining of this thickness shall extend 1 foot beyond the edge of the beam for any position of the tube inclosure with its largest possible diaphragm aperture. When there is any doubt as to the limits of the beam the whole room should be lined with 2.5 mm. of lead.

3.06. Protection from direct and useful radiation as indicated in Paragraphs 3.04 and 3.05 may be omitted only on sides adjacent to permanently unoccupied rooms or outside building walls.

I. Protection from Scattered Radiation.—3.07. In the case of Paragraphs 3.04 and 3.05, the entire remaining portions of the room shall be lined with sheet lead 1.5 mm. thick.

3.08. All control apparatus shall be located in an adjacent room or in a completely inclosed, well-ventilated booth lined with 2.5 mm. lead. Such a room or booth shall be provided with a suitably large protective glass window or windows of 2.5 mm. lead equivalent, so placed as to afford ready view of the patient and meters while the operator is in a normal and comfortable position.

3.09. The tube container and treatment table should be so arranged that the useful beam points away from the technician's booth, offices, etc.

3.10. When thermionic rectifiers are used they shall be either placed in a separate room or surrounded by protective material of 0.1 mm. lead equivalent.

3.11. There shall be mounted in the diaphragm of the tube container, between the tube and the filter, a layer of asbestos board at least 0.5 mm. thick to prevent a melted target from falling upon a patient.

4. *Special Requirements for Apparatus in Class C*[4]

J. Protection from Direct Radiation.—4.01. The X-ray tube shall be completely inclosed in a protective inclosure so that all direct radiation is shielded off in all directions by protective material having lead equivalent as given in Table II.

4.02. This equivalent thickness may be reduced by an amount equal to the thickness of the lead lining of the room except that in no case shall less than half of the lead protection be provided by the tube inclosure. (See Pars. 4.05, 4.06, and 4.08.)

4.03. The diaphragm of the tube container shall have a permanent covering of asbestos board at least 0.5 mm. thick, placed between tube and filter, next to the filter.

4.04. In the case of tube containers for water-cooled tubes, the diaphragm shall be sealed water-tight.

4.05. When the X-ray tube is so arranged that the radiation can be taken off in only

[4]X-ray installations for voltages from 140 to 250 K.V. peak, in which the X-ray tube is housed in an inclosure affording the requisite protection from all direct radiation.

one fixed direction, a sheet of lead of thickness in accordance with Table II shall be placed in the path of the direct or useful beam on the floor, wall, or ceiling opposite the diaphragm. This lead sheet shall extend one foot in all directions beyond the border of the X-ray beam, determined by the largest possible aperture in the tube inclosure.

4.06. When the X-ray tube is so arranged that radiation can be taken off in several directions, all parts of the room which may possibly be reached by the direct or useful beam of radiation shall be lined with sheet lead in accordance with Table II. The lead lining of this thickness shall extend one foot beyond the edge of the beam for any position of the tube inclosure with its largest possible diaphragm aperture. When there is any doubt as to the limits of the beam, the whole room should be lined with lead in accordance with Table II.

K. Protection from Scattered Radiation.—4.07. In the case of Paragraphs 4.05 and 4.06, the entire remaining portions of the room shall be lined with sheet lead having a thickness of 1 mm. less than the values specified in Table II.

4.08. All control apparatus shall be located in a separate room.

4.09. Such control rooms shall have a protective glass window or windows of the same lead equivalent as the wall and should be so located that the operator may, while in a normal and comfortable position, have a ready view of the patient and meters.

4.10. When thermionic rectifiers are used, they shall be placed either in a separate room or surrounded by protective material of 0.2 mm. lead equivalent.

II. ELECTRICAL PROTECTION

5. *General Electrical Safeguard Rules for Installation of All X-ray Apparatus*

5.01. X-ray installations may be connected to power mains by suitable, approved plug and cable if the input corresponding to the rated capacity of the fused mains does not exceed 6.5 kilovolt-amperes. In the use of plug and cable, the voltage and wattage rating of each shall be clearly and permanently indicated. Leads to such apparatus shall be according to the regulations of the National Electrical Code.

5.02. If the power input under Paragraph 5.01 exceeds 6.5 kilovolt-amperes, the X-ray apparatus shall be permanently connected to the mains by means of an approved inclosed switch. A double-pole switch shall be used for direct and single phase current and a triple-pole switch for 3-phase current. In the use of a 220-volt 3-wire system the neutral shall be unfused.

5.03. If a transformer, rotary-converter, or motor-generator set be interposed between the mains and the X-ray apparatus, a suitable switch shall be inserted in the line between same and any X-ray apparatus.

5.04. The switch referred to in Paragraphs 5.02 and 5.03 shall be secured by a locking device or by gravity in the "off" position, and shall be inclosed in a suitable grounded metal box.

5.05. A foot switch used as an operating switch for the X-ray transformer shall be in series with an auxiliary switch located on the control panel.

5.06. A foot switch shall have a rigid shield above the button so arranged that the switch can not be closed by accidentally stepping upon it.

5.07. A foot switch or hand switch shall be so constructed that for operation it is required to be held on. No locking device shall be permitted. If a foot or hand switch operates through a relay, the relay shall open upon release of the foot switch.

5.08. A time switch used as an operating switch for the X-ray transformer shall be in series with an auxiliary switch located on the control panel.

5.09. All X-ray apparatus shall be provided with a quick-acting, magnetic overload circuit-breaker interposed between the transformer and the supply circuit. This should preferably be an integral part of the apparatus and permanently installed therein.

5.10. The value of the tripping current shall be adjustable and clearly indicated on the circuit-breaker. For diagnostic apparatus the tripping current of the breaker shall be adjusted to a 40 per cent overload on the primary of the transformer, based on the maximum working voltage and current. For therapy apparatus the tripping current shall be adjustable to 20 per cent overload on the primary.

5.11. The installation of water coolers shall comply with all regulations pertaining to high tension equipment and high tension conductors.

6. Rooms for X-ray Equipment

6.01. All high tension generators shall be made inaccessible by means of an insulating barrier or a grounded metal barrier or shall be installed in a separate room. In any case, a switch shall be so arranged in the transformer primary circuit that the transformer will be immediately disconnected when the door leading to such an inclosure is opened. Furthermore, it shall be impossible to close this switch except from outside the inclosure after the door is closed.

6.02. In case of such inclosures for valve tube equipment having condensers in the high tension circuit, there shall be, in addition to the specification in Paragraph 6.01, a device so arranged that both sides of the high tension system are automatically grounded when the door to the inclosure is opened in excess of 18 inches.

6.03. When the X-ray generator is self-contained in a wooden inclosure wherein the spark-over distances are in accordance with Paragraphs 7.02, 7.03, and 7.04, and where no exposed high tension leads are accessible or less than 7.5 feet above the floor, then Paragraph 6.01 shall be invalid.

6.04. No control room shall be so separated from the treatment or examination room that the person operating the control panel does not have at all times a clear view of such treatment or examination room.

6.05. In the case of fluoroscopic equipment, where the generating apparatus is controlled by means of a foot switch used in accordance with Paragraphs 5.05, 5.06, and 5.07, the control room may be separated from the fluoroscopic room. In such a case, there shall be in the examining room a device which indicates automatically and continuously during the time that the transformer primary switch located on the control board is closed.

6.06. If an X-ray generator be permanently installed in a therapy or diagnostic room, so that its high tension terminals are less than 7.5 feet above the floor, it shall be surrounded either by an earthed metal barrier or insulating barrier in accordance with Paragraphs 7.02, 7.03, and 7.04.

7. Insulated High Tension Barriers

7.01. A grounded metal grid or screen may be used as a protective barrier if the mesh area does not exceed one-half inch square.

7.02. For X-ray apparatus earthed at one pole, a protective barrier of insulating material, including the air space between the latter and any high tension part, shall provide an insulation necessary to withstand twice the maximum operating voltage and shall in no case be placed nearer to any high tension part than the equivalent needle point spark gap distance, as given in Table I, corresponding to the maximum operating voltage.

7.03. For X-ray apparatus with the neutral of the high tension generator permanently grounded through a low resistance, the protective barrier, including the air space be-

tween the barrier and any high tension part, shall provide an insulation necessary to withstand the total maximum operating voltage, and in no case be placed nearer to any high tension part than the equivalent needle point spark gap distance, as given in Table I, corresponding to one-half the maximum operating voltage.

7.04. For X-ray apparatus with no part of the high tension grounded, the protective barrier, including the air space between barrier and any high tension part, shall provide an insulation necessary to withstand twice the total maximum operating voltage, and in no case be placed nearer to any high tension part than the equivalent needle point spark gap distance, as given in Table I, corresponding to the maximum operating voltage.

8. High Tension Conductors

8.01. All permanent overhead high tension systems shall be constructed of metal rods or tubes of sufficient diameter to provide rigidity and prevent corona.

8.02. Sharp edges or points in the high tension system should be avoided so far as possible in order to minimize brush discharges.

8.03. All parts of high tension overhead conductors, including meters and stabilizers, shall not be less than a distance of 7.5 feet above the floor for all installations operating below 250 K.V. unless surrounded with grounded metal guards or insulating guards in accordance with Paragraphs 7.02, 7.03, and 7.04.

8.04. High tension parts installed in completely inaccessible parts of treatment, diagnostic, or machine rooms may be placed at lower heights than specified in Paragraph 8.03.

8.05. All insulating supports for high tension aerials, high tension stabilizers, meters, etc., must withstand a dead-weight load of 50 pounds.

8.06. All water coolers for X-ray tubes shall be constructed of metal and the gauge glass (if one is used) suitably protected against breakage by a metal guard when the cooler is in a treatment room.

8.07. The water tubes connecting the water cooler and X-ray tube shall be of metal or rubber tubing covered with a tightly fitting metal sheath.

8.08. If a high tension switch is used it shall be so constructed that only one set of apparatus can be connected at one time. High tension switches for controlling apparatus in separated rooms shall have a suitable automatic signal which indicates before operation in each room so controlled. When possible such high tension switches should be inoperable except when the main generator circuit is open.

9. High Tension Leads to Tubes

9.01. Permanent high tension leads to X-ray tubes should be used when possible.

9.02. Temporary leads to X-ray tubes shall be of stranded wire and so arranged as to prevent accidental disconnection.

9.03. If the leads are not detached from the overhead high tension conductors when not in use, the lowest hanging part thereof shall comply with Paragraph 8.03.

9.04. In installations having movable and easily accessible high tension leads, precautions shall be taken that such leads are never at a distance from tube stands, apparatus, and metal parts less than 1.2 times the distance given in Table I for the voltage used.

9.05. When the patient is not fully protected from easily accessible high tension leads by a suitable grounded metal barrier, the distance between high tension parts and patient shall be at least twice the distance given in Table I for the voltage used.

9.06. In appliances for fluoroscopy or radiography where the tube is below or behind the table or stand, the connecting leads to the tube shall be shielded by a suitable

grounded metal guard or insulating guard in compliance with Paragraphs 7.01, 7.02, and 7.03. When so-called "masts" are employed, they shall also be surrounded by a grounded metal guard.

9.07. When using an X-ray tube having any exposed high tension parts, the table shall be insulated from ground by suitable material capable of withstanding 1.5 times the maximum working voltage to ground.

9.08. Metal parts of X-ray apparatus, such as tube stands, transformer tanks, motors, controls, etc., shall be permanently grounded to a water pipe through at least a No. 6 B. & S. gauge wire or the equivalent. This wire must be suitably protected against accidental breakage.

III. X-RAY EQUIPMENT IN ANESTHETIC ROOMS

10. Special Requirements in Addition to Sections 1 to 9

10.01. Inflammable anesthetics shall include: Ether, ethylene, propylene, ethyl chloride, and nitrous oxide when used in conjunction with ether.

10.02. All open high tension generating equipment shall be located in a well-ventilated room completely isolated from the anesthetic room, and any connecting doors or windows shall be effectively air-tight. (The doors should close against soft rubber or felt padding.)

10.03. A completely self-contained transformer and X-ray tube unit in an effectively air-tight inclosure is recommended (though not required) for use in all anesthetic rooms.

10.04. Foot switches and all other control devices shall be inclosed in a completely vapor-proof container in accordance with Section 3,203 of the 1930 National Electrical Code.

10.05. The Committee indorses the Recommended Safeguards for the Installation and Operation of Anesthetic Apparatus Employing Combustible Anesthetics, by the National Board of Fire Underwriters, June 1, 1929.

IV. STORAGE OF X-RAY FILM

11. General Remarks

11.01. Regulations of the National Board of Fire Underwriters for the Storage and Handling of Photographic and X-ray Nitrocellulose Films, of July 15, 1930, shall be adhered to in detail.

11.02. The Committee gives its unqualified indorsement to the sole use of film of slow-burning or safety-base (cellulose acetate) type. It is specifically pointed out that such film constitutes no greater fire hazard than ordinary newspaper in the same form.

11.03. The regulations of the Board of Underwriters as given below apply only to the use of nitrocellulose film.

11.04. The following paragraphs are extracted from the regulations cited in Paragraph 11.01:[5]

11.05. Film of a slow-burning or safety-base (cellulose acetate) does not have a fire hazard characteristic of nitrocellulose film. The use of film of slow-burning or safety-base (cellulose acetate) is recommended for hospitals and similar institutions, doctors' offices, X-ray laboratories, and the like. The cellulose acetate film (safety film) is in a class with ordinary newsprint paper in similar form and quantity in respect to the hazard to life of its smoke and fumes in a fire. Where large amounts are stored the use of steel filing cabinets is recommended.

11.06. Where both kinds of film are used or stored at the same location in any building the requirements for nitrocellulose film shall apply.

[5]These paragraphs have been reprinted by permission of the National Board of Fire Underwriters. The numbering of the paragraphs has, however, been altered so as to conform to the system used in these recommendations. Paragraphs not related directly to the storage of X-ray film have been omitted.

11.07. These regulations, based on available knowledge and field experience, prescribe such methods for protection against the hazards of handling and storage of photographic and X-ray nitrocellulose films as are judged to be of practicable application in types of buildings and occupancies where such hazards are encountered, but it should be recognized that in the event of fire involving the decomposition of such quantities of films as it is contemplated may be stored in the vaults, cabinets, or containers covered by these regulations a hazard to life remains, depending upon the care and supervision exercised and the precautions taken in the handling of the film.

11.08. Safety photographic and X-ray film (cellulose acetate base) may be identified by the marking on the edge of the film. This marking shows plainly before and after developing. Where film is not so marked it should be inspected to determine whether it is of the safety acetate or nitrate type.

11.09. These regulations do not apply to safety film (cellulose acetate base) and dental X-ray film.

12. Hospitals and Similar Institutions, Doctors' Offices, and X-ray Laboratories

12.01. Storage of unexposed films shall be in unopened I. C. C. shipping containers or in approved cabinets vented to the outside air or in vented storage vaults or outside storage houses. Only one I. C. C. shipping container of each size shall be opened at one time. Where the total aggregate exceeds 50 cubic feet, storage shall be in a vented storage vault in accordance with Sections 13.12 to 13.27, or in an outside storage house in accordance with Sections 13.28 to 13.34.

13. Storage of Film Negatives

The following paragraphs apply only to film negatives (developed film).

General.—13.01. Storage of film negatives in basements is prohibited.

13.02. Film negatives in storage or in process of handling shall be kept in heavy manila envelopes, not exceeding 12 films to an envelope. Expanding envelopes shall not be used.

Portrait and Commercial Studios.—13.03. Film negatives shall be kept in approved vented cabinets (see Secs. 13.05 to 13.11) or in vented storage vaults or outside storage houses. Not more than 250 pounds shall be stored in any single cabinet. Where the film stored exceeds 1,000 pounds it shall be in vented storage vaults (see Secs. 13.12 to 13.27), or in a detached structure or roof vault (see Secs. 13.28 to 13.34).

NOTE.—The following table may be used as a guide in computing the weight of film.

Number of negatives	Size	Approximate weight
	inches	pounds
1,000	14 by 17	118
1,000	10 by 12	60
1,000	8 by 10	40

(Other sizes in proportion to area.)

Hospitals and Similar Institutions, Doctors' Offices, and X-ray Laboratories.—13.04. All film negatives shall be stored in approved vented cabinets in accordance with Sections 13.05 to 13.11, or in outside storage houses. Approved cabinets shall be provided convenient to X-ray rooms for current use. Storage in excess of 500 pounds of film shall be in an outside storage house in accordance with Sections 13.28 to 13.34. Storage house may be located on the roof. Vaults shall not be located within the building.

Vented Cabinets.—13.05. No single cabinet shall exceed 10 cubic feet capacity. Not over 250 pounds of film shall be kept in any single cabinet.

NOTE.—Each insulated vented unit is considered as a single cabinet.

13.06. All cabinets shall be of approved insulated construction.

NOTE.—Under average conditions of storage of film in manila envelopes (six films to the envelope), 1 cubic foot of storage represents approximately 20 pounds of film, due allowance being made for space not occupied by film. Actually 1 cubic foot of film negatives in envelopes weighs from 60 to 64 pounds.

13.07. Cabinets shall be equipped with at least one automatic sprinkler in each compartment (unit) unless specifically approved for use without automatic sprinklers.

13.08. Each cabinet shall be provided with a vent to the outside of the building. For a cabinet of 10 cubic feet inside volume the vent opening shall be not less than 56 square inches. For smaller cabinets the vent area shall be in proportion to the volume, except that no cabinet shall have a vent area of less than 14 square inches. The vent of the cabinet shall be so constructed or protected by a substantial metal grid as to prevent stoppage of vent in case of combustion or decomposition of film contents.

13.09. The vent areas given in these regulations are based upon a vent for a pipe length of 10 feet. For longer lengths due allowance shall be made for friction loss and turns in pipe.

13.10. The outlet of each vent shall be above roof and at least 25 feet from doors, windows, other openings, or fire escapes.

13.11. Vent flues shall be of construction equivalent to that required for chimneys or of riveted sheet metal not thinner than No. 18 U. S. gauge; if inside the building, they shall be covered with 1 inch of approved heat insulating material and not nearer than 9 inches to any combustible material.

Vented Storage Vaults (Inside).—13.12. No vault shall exceed 750 cubic feet in actual storage capacity, including aisles.

13.13. The floor and walls of every vault shall be made of brick at least 8 inches thick or of reinforced concrete at least 6 inches thick. In fireproof buildings the building floor may be used as the floor of the vault if equivalent in fire resistance to the requirements given above. Vaults shall be supported by masonry or steel of sufficient strength to carry the load safely. Beams shall rest at both ends on steel girders, iron or steel columns, or walls or piers of masonry. The supports shall afford at least four hours' protection as determined by the Standard Fire Test Specifications. Hollow tile shall not be used for foundation walls.

NOTE.—Where the design of the buildings is such that an excessive floor load would result from having the film vault filled with water, the film vault shall be provided with one or more scuppers, giving a total area of outlet equal to 3 square inches for each sprinkler head installed in the film vault. A depth of 10 feet of water will result in a floor load of 626 pounds per square foot.

13.14. The roof of vault, if inside the building, shall be an independent reinforced-concrete roof at least 6 inches thick; in a fireproof building, where the floor above is equivalent to this, it may serve as the roof if side walls are rigidly tied into it; in construction of this type a false ceiling construction of metal lath and cement plaster 1 inch thick, or the equivalent, and with no openings to the concealed space above, may be used to limit the total interior vault space to 750 cubic feet. Vent may extend through this false ceiling and concealed space.

13.15. Vaults shall not be provided with skylights or glass windows other than as specified under vents.

13.16. Proximity to boilers, stacks, or other sources of heat shall be avoided. Where heating is necessary to prevent freezing, coils shall be provided at the ceiling over aisle space. Pipes and radiators shall be so screened that film can not come within 2 feet of them. Only hot water or low pressure steam heating shall be allowed, with automatic control limiting pressure to 10 pounds per square inch and temperature to not in excess of 100° F. No indirect heating, nor arrangement employing fans for air circulation, shall be employed.

13.17. Door openings in vault shall be protected by an approved vault door of 4-

hour or longer classification. It shall be kept closed except when in use.

13.18. In lieu of the above, door openings may be protected on each side by an approved fire door suitable for use in Class B situations. The interior door shall be automatic. The outer door shall be of the swing type and close into an approved frame. It shall be self-closing, and if fastened open shall be arranged to close automatically in case of fire originating in or out of vault.

NOTE.—A vault door if kept shut, will provide superior protection against the passage of fumes.

13.19. Films in vaults shall be stored upon shelves, or in cabinets which are designed to permit the effective distribution of water from automatic sprinklers and are specifically approved for use in vaults. Ordinary filing cabinets shall not be used in vaults. If wooden shelving is used, this shall be of slatted construction, with slats not over 4 inches wide and spaced at least 1 inch apart. If steel shelving is used, the shelves shall be perforated to the amount of at least 20 per cent of the shelf area. Shelves of iron pipe, angles or similar construction shall have open spaces to the amount of at least 20 per cent of the shelf area. Vertical incombustible partitions, equivalent in heat insulation and durability to three-eighths-inch hard asbestos, shall be provided to divide shelving into sections not over 3 feet wide and so placed as not to obstruct distribution from sprinkler heads.

13.20. Each vault shall be equipped with approved automatic sprinklers or with an open-head sprinkler system controlled by heat-actuated devices, the system to be approved for this particular use. Sprinklers shall be arranged according to the sprinkler regulations in so far as applicable. The area to be covered by each sprinkler head shall not exceed 15 square feet of floor area. Proper baffles shall be provided between heads.

13.21. Substantial metal grids of approximately 2-inch mesh shall be installed to prevent clogging or stoppage of vent and piling of film above the top of the shelving or cabinets higher than 2 feet below the sprinklers, and thus interfering with distribution of water.

13.22. Each vault shall separately vent to the outer air, with a vent having a minimum effective sectional area of 150 square inches per 1,000 pounds of film capacity. For a standard vault of 750 cubic feet containing 10,000 pounds of film the vent opening shall be 1,500 square inches.

13.23. The outlet of each vent shall be above roof and at least 25 feet from doors, windows, other openings, or fire escapes.

13.24. All horizontal or vertical flues inside of the building shall be of 5-inch reinforced concrete or of a construction equivalent to that of chimneys.

13.25. Exterior metal flues shall be of a construction equivalent to that of smokestacks.

13.26. Each vent opening directly through an exterior wall shall be protected against the weather by single-thickness glass (one-sixteenth inch thick), painted a dark color, or by other incombustible fragile material, in a sash arranged to open outward automatically in case of fire by the use of an approved releasing device placed inside the film storage. The area of the glass shall be the effective sectional area of the vent opening. No pane of glass shall be smaller than 200 square inches.

13.27. A light wire screen not coarser than one-eighth-inch mesh shall also be placed over each vent, so arranged as not to interfere with the automatic operation of the sash. Bars or screen, if used to prevent burglary or injury to contents, shall not have a mesh of less than 4 inches, shall be located inside the light wire screen, and shall give a net opening equal to that called for under Paragraph 13.22.

Outside Storage Houses.—13.28. Build-

ings should preferably be located at least 100 feet away from any other building or combustible material. If on a roof, or within 100 feet of any other building or combustible material stored in the open, the building shall have all walls equivalent in fire resistance to 4 inches of concrete, or 3-cell 8-inch tile. Door openings in such walls shall be protected by approved fire doors suitable for use in Class B situations. Skylights shall be protected in such a manner as to prevent radiated heat or flying brands from igniting the contents of the building.

13.29. Buildings exceeding 750 cubic feet capacity shall be divided into sections of not over 750 cubic feet by unpierced walls of construction equivalent to that required for the exterior walls.

13.30. In hospitals access to the outside storage rooms shall be by means of a balcony or vestibule open to the outside air, with no direct communication between the room and the building.

13.31. Heating shall be in accordance with Section 13.16.

13.32. Interior equipment shall be in accordance with Section 13.19.

13.33. If the storage house is located within 100 feet of any other building, automatic sprinkler protection shall be provided in accordance with Sections 13.20 and 13.21.

13.34. Vents shall be in accordance with Sections 13.22 and 13.23.

14. General

(Applies to both unexposed films and film negatives.)

14.01. All wiring and equipment shall conform to the National Electrical Code. See Article 32, Hazardous Locations.

14.02. Only incandescent electric lights shall be permitted. In storage rooms these shall be protected with either substantial wire guards or vapor-proof globes, or both.

14.03. The use of portable lights on extension cords in any storage room or vault is prohibited.

14.04. Illuminators shall be so built that the diffusing glass does not become overheated. There shall be no unnecessary display of negatives in lighted illuminators.

14.05. Smoking shall be prohibited in rooms where film is handled or stored. Conspicuous "No smoking" signs shall be posted in prominent places.

14.06. No films shall be stored within 2 feet of steam pipes, radiators, chimneys, or other sources of heat.

14.07. Film driers, if used, shall be of approved type.

14.08. First-aid fire appliances of types using water or water solutions shall be provided for the protection of all rooms containing film.

NOTE.—The following types of extinguisher are considered suitable: Soda-acid, pump tank, calcium chloride, and loaded stream. Small hose equipment is likewise suitable.

14.09. Discarded film shall be stored and handled in the same manner as other film until removed from the premises.

V. OPERATING RULES

15. Rules for Technicians, Nurses, etc.

15.01. A copy of these rules shall be given to every X-ray worker, whether temporary or otherwise, upon entering service. A signed receipt stating that the rules are understood shall be given to the physician in charge of the department.

15.02. A copy of these rules, together with a copy of first-aid instructions for electrical shock, shall be posted conspicuously in all principal X-ray rooms.

15.03. Protective gloves and aprons, even though in compliance with these recommendations, do not afford adequate protection. Consequently, care shall be taken at all times not to expose the body unnecessarily to radiation.

15.04. Lead-rubber becomes hard and

brittle with age, and all such protection should be tested at regular intervals for possible cracks and imperfections. This test should be made radiographically or radioscopically.

15.05. Radioscopic work should be performed in the minimum time possible, using the lowest X-ray intensity and smallest aperture consistent with demands. It is important, however, that the fluoroscopist use sufficient X-ray intensity so that he can see without eyestrain.

15.06. The omission of any protective devices for the sake of expediency of operation shall be strictly forbidden.

15.07. Before touching any X-ray generator or high tension part, particular care shall be taken to make sure that the main-line switch is open and the whole apparatus is disconnected from the power line.

15.08. In the case of equipment having high tension condensers, care shall be taken that both sides of the high tension are actually and securely grounded before touching any part thereof.

15.09. If the transformer and controls are located in a remote room, a plaque reading "DO NOT TOUCH" shall be hung over the main-line switch when it is necessary to touch high tension parts in another room.

15.10. Where several appliances for treatment or examination may be connected to a common high tension system, care shall be taken that conductors to all idle equipment are disconnected.

15.11. Where the machine operation depends upon two persons, a distinctly audible or visible signal shall be given by the operator before throwing on the high tension, and a return signal received from the person using the equipment.

15.12. Any acoustical or optical signal system for protective purposes should be checked daily before commencing work.

15.13. The main switch should be opened immediately upon completion of the X-ray work, or when the machine is not in actual use.

15.14. The high tension overhead system should be examined frequently for possible faulty insulators or loose parts.

15.15. A daily check shall be made, to be certain that no idle flexible high tension leads extend below the minimum prescribed height above the floor.

15.16. All grounding connections shall be examined weekly.

15.17. All high tension barriers shall be examined frequently. When possible, this should be done when cleaning the apparatus.

15.18. In case of fire in the X-ray or control rooms, or in any part of the building, all X-ray apparatus should be immediately disconnected from the mains by opening the main power line switch.

15.19. All workers should be thoroughly familiar with the Schaeffer prone pressure method of resuscitation in case of electric shock, and a set of such instructions should be posted conspicuously in each main room. Above the description of the method should be placed the instructions:

This hospital may be provided with pulmotor or other resuscitation apparatus. Do not wait to send for it, but proceed immediately with the Schaeffer prone pressure method.

15.20. How to give artificial respiration by the prone pressure method:[6]

1. Lay the patient on his belly, one arm extended directly overhead, the other arm bent at elbow and with the face turned outward and resting on hand or forearm, so that the nose and mouth are free for breathing. (See Fig. 1.)

2. Kneel straddling the patient's thighs with your knees placed at such a distance from the hip bones as will allow you to assume the position shown in Figure 1.

Place the palms of the hands on the small of the back, with fingers resting on the ribs, the little finger just touching the lowest rib,

[6]Reprint from the Public Health Reports, Jan. 20, 1928, XLIII, No. 3, pp. 111, 112.

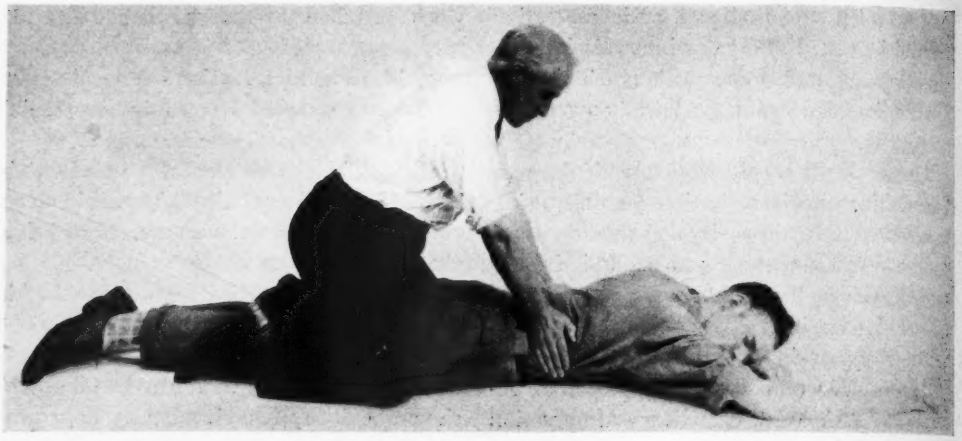


Fig. 1. Resuscitation Position No. 1.

Fig. 2. Resuscitation Position No. 2.

with the thumb and fingers in a natural position, and the tips of the fingers just out of sight. (See Fig. 1.)

3. With arms held straight, swing forward slowly, so that the weight of your body is gradually brought to bear upon the patient. The shoulder should be directly over the heel of the hand at the end of the forward swing. (See Fig. 2.) Do not bend your elbows. This operation should take about two seconds.

4. Now immediately swing backward, so as to remove the pressure completely. (See Fig. 3.)

5. After two seconds swing forward again. Thus repeat deliberately twelve to fifteen times a minute the double movement of compression and release, a complete respiration in four or five seconds.

6. Continue artificial respiration without interruption until natural breathing is restored; if necessary, four hours or longer,

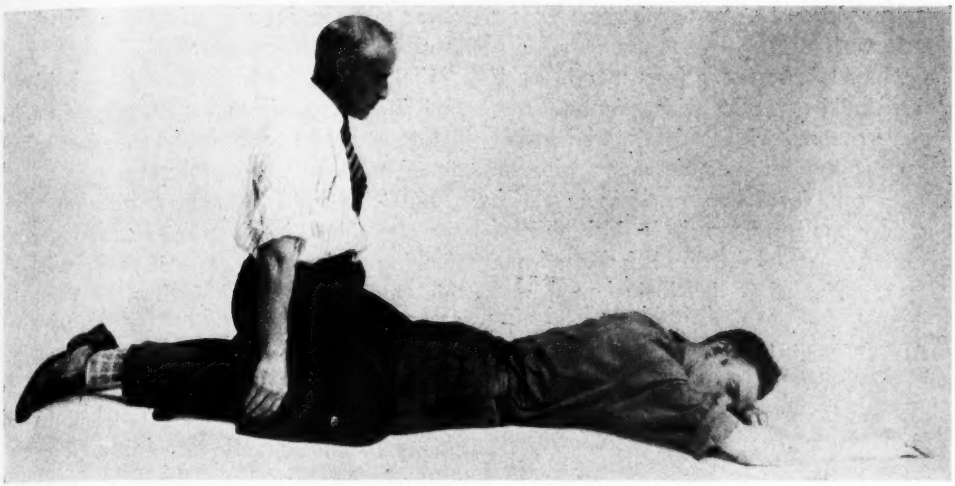


Fig. 3. Resuscitation Position No. 3.

or until a physician declares the patient is dead.

7. As soon as this artificial respiration has been started and while it is being continued an assistant should loosen any tight clothing about the patient's neck, chest, or waist. Keep the patient warm. Do not give any liquids whatever by mouth until the patient is fully conscious.

8. To avoid strain on the heart when the patient revives, he should be kept lying down and not allowed to stand or sit up. If the doctor has not arrived by the time the patient has revived, the latter should be given some stimulant, such as one teaspoonful of aromatic spirits of ammonia in a small glass of water or a hot drink of coffee or tea, etc. The patient should be kept warm.

9. Resuscitation should be carried on at the nearest possible point to where the patient received his injuries. He should not be moved from this point until he is breathing normally of his own volition and then moved only in a lying position. Should it be necessary, due to extreme weather conditions, etc., to move the patient before he is breathing normally, resuscitation should be carried on during the time that he is being moved.

10. A brief return of natural respiration is not a certain indication for stopping the resuscitation. Not infrequently the patient, after a temporary recovery of respiration, stops breathing again. The patient must be watched, and if natural breathing stops, artificial respiration should be resumed at once.

11. In carrying out resuscitation it may be necessary to change the operator. This change must be made without losing the rhythm of respiration. By this procedure no confusion results at the time of change of operator, and a regular rhythm is kept up.

16. Rules for Physicians in Charge

16.01. The efficiency of X-ray protection and protective devices shall be examined upon installation and yearly thereafter. This shall be accomplished with a fluorescent screen fitting closely over the eyes. The detection of any fluorescence by the well dark-adapted eye shall be considered a hazard and be remedied.

16.02. For the purpose of providing safety for the working personnel, it is recommended that such annual inspection of

X-ray protection be conducted by an expert in such work.

16.03. At least every four months each worker shall be supplied with a dental X-ray film half covered with lead foil, which shall be worn on the breast continuously, with the film side out, for fifteen working days. If, upon development, appreciable darkening of the exposed part of the film is indicated, the cause therefor shall be investigated and eliminated.

16.04. Circuit-breakers should be examined monthly to be certain that the overload adjustment is correct.

17. Personnel Working Conditions

17.01. It is the duty of the physician in charge of an X-ray department to be responsible for the health and safety of all workers insofar as conditions permit.

17.02. Favorable working conditions shall include provision for workers of ample light and sunshine, fresh air, sufficient spare time, and satisfactory protection.

17.03. Every assistant, technician, and operator should be given at least four weeks' vacation a year with at least two weeks of this consecutively and during the summer months.

17.04. All persons occupied in radiological work should be examined for general radiation injuries yearly. Complete blood counts should be made bimonthly. The results of all tests and examinations should be permanently recorded. It is advisable that all persons be carefully examined before entering radiological work.

THE CLINICAL VALUE OF CHOLECYSTOGRAPHY BY THE ORAL METHOD[1]

By D. S. BEILIN, M.D., and G. D. CARLSON, M.D., Radiologist and Resident-in-Radiology, Respectively, Augustana Hospital, CHICAGO, ILLINOIS

THIS paper is based on a study of 750 cases referred to the Department of Radiology for examination of the gall bladder. Of these, operation was done on 150. Although the number of cases is relatively small, the careful evaluation of the radiographic, clinical, surgical, and pathologic findings merits this report. The clinician and surgeon desire to know the presence or absence of gall-bladder disease. The clinical value of the roentgen diagnosis in oral cholecystography is demonstrated in this series by the surgical and pathological findings in the cases upon which operation was done.

When is a gall bladder clinically pathologic? There apparently is a diversity of opinion among surgeons. In our institution we have set down certain criteria for a pathologic gall bladder which are consistent with the viewpoints of most clinical pathologists. We classify cholecystitis as either acute or chronic. The inflammation of the gall bladder is usually associated with cholangitis. The cholangitis is usually primary, and the cholecystitis secondary. Occasionally, the converse is true. In acute cholecystitis the gall bladder is injected, the walls thickened and edematous; the mucosa is swollen and secretes abundant mucus. It may terminate in the suppurative form often called "empyema of the gall bladder." The organ, then, appears greatly swollen and tense; pericholecystitis often follows, with resultant adhesions. Obstruction of the cystic duct is very common, caused by calculi, inflammation, inspissated bile, large glands along the ducts, and malignancy.

The most common type of chronic cholecystitis is associated with obstruction of the cystic duct, usually due to one or more stones, and often the gall bladder is filled with calculi. There may be only a slight thickening of the wall, or adhesions involving either the duodenum or colon, or both; slight change in color towards a gray, or enlarged glands along the cystic or common ducts. In marked cases the wall of the gall bladder may attain a thickness of one-half inch and become fibrotic in character, with extensive adhesions. A not infrequent type of chronic cholecystitis is cholesterosis, or so-called "strawberry gall bladder."

Gallstones are, most of all, pathognomonic signs of gall-bladder disease. It is true that certain individuals harbor calculi within the bile sac with no apparent clinical manifestations. However, there is sufficient evidence to support the belief that there are no innocent gallstones, as the infection is the entity and calculi are secondary to it.

Carcinoma of the gall bladder arises from the mucous glands, either at the fundus or the neck, and rapidly infiltrates the adjoining parts, the liver being involved early. Malignancy of the gall bladder is often associated with calculi.

Roentgenologists throughout the country have reported the reliability of cholecystography by the oral method. It is only necessary that the management and technic of the examination be exacting. Although the incidence is small, errors in cholecystographic interpretation may result from causes extrinsic to the gall bladder. The following conditions were found to be causes of non-visualization of the gall bladder: hepatitis; cirrhosis; cholangitis; malignancy

[1]Read before the Radiological Society of North America at the Sixteenth Annual Meeting, at Los Angeles, December 1-5, 1930

of the stomach, liver, and pancreas; less frequently, duodenal ulcer, duodenitis, and achlorhydria. One must bear in mind the possibility of congenital absence of the gall bladder, as well as transposition of the abdominal viscera, in which case the gall bladder would be in the upper left quadrant. We report two such cases. It is evident that cholecystographic interpretation must be made with some caution. With an examination of the gastro-intestinal tract, the possibility of error in interpretation is reduced to a minimum.

There have been many opinions expressed as to secondary reactions from the dye in oral cholecystography. It is because of the simplicity of the examination and the freedom from reactions that the oral administration of the dye is so advantageous. In 200 cases of this series the secondary reactions from the dye were carefully studied. In order to evaluate them, it is imperative to know the symptomatology of the patient before the administration of the test. It is interesting to note that these secondary reactions are identical with the symptoms complained of by individuals with gall-bladder disease.

Those cases in which the preliminary roentgenogram showed considerable gas and fecal material in the colon in the upper right quadrant were given compound licorice powder as a laxative.

The secondary reactions from the dye are: nausea, vomiting, diarrhea, headache, and weakness. Of the 200 cases studied, 111, or 55.5 per cent, had a history of nausea as a symptom before the administration of the dye; 89, or 44.5 per cent, had no nausea; 17, or 8.5 per cent, having no nausea as a symptom, had nausea subsequent to the administration of compound licorice powder, plus the dye; 7, or 3.5 per cent, with no nausea as a symptom, and having had no licorice powder, had nausea after the dye.

Of the same series of 200, 61 cases, or 30.5 per cent, had vomiting as a symptom before the administration of the dye; 139, or 69.5 per cent, had no vomiting as a symptom; 4, or 2 per cent, having no vomiting as a symptom before the dye, had vomiting after taking licorice powder, plus the dye; 3, or 1.5 per cent, with no vomiting as a symptom, and having had no licorice powder, vomited after taking the dye.

Of the same, 8 cases, or 4 per cent, had diarrhea as a symptom before the administration of the dye; 192 cases, or 96 per cent, had no history of diarrhea before taking the dye; 30, or 15 per cent, with no diarrhea as a symptom, had diarrhea after taking compound licorice powder, plus the dye; 4, or 2 per cent, with no diarrhea as a symptom, and having had no licorice powder, had diarrhea from the dye.

Likewise, 88 cases, or 44 per cent, had headache as a symptom before taking the dye; 112, or 56 per cent, had no headache as a symptom; 13, or 6.5 per cent, with no headache as a symptom, had headache after the administration of licorice powder, plus the dye; 1, or 0.5 per cent, with no headache as a symptom, and having had no licorice powder, had headache after the dye.

Of the series of 200 cases, 75, or 37.5 per cent, had weakness as a symptom before taking the dye; 125, or 62.5 per cent, had no symptom of weakness; 15, or 7.5 per cent, with no symptom of weakness, had weakness after licorice powder, plus the dye; 1 case, or 0.5 per cent, with no symptom of weakness, and having had no licorice powder, had weakness after the dye.

This study shows that the secondary reactions from the dye, when taken orally, are of minor importance. None of the patients in this group suffered clinically as a result of the test.

Of the 150 cases of this series that were operated on, 123 had an X-ray diagnosis of pathologic gall bladder, and 27 were reported as having normal gall bladders. Of

the 123 patients who had an X-ray diagnosis of pathologic gall bladder, 63, or 51.22 per cent, had no gall-bladder shadow. The surgical and pathologic findings of these 63 cases showed that 15 cases had cholecystic disease, and 48 had cholelithiasis, associated with cholecystic disease. In 15, the stones were opaque and diagnosed by the X-ray, whereas in 33, or 69 per cent, the stones were translucent to the X-ray. In our previous investigations we had found that in 70 per cent of the cases in which the gall bladder did not fill after the dye, the former contained cholesterol or translucent stones. Therefore, based upon this series of cases, we have made the statement: "In all cases in which the gall bladder does not fill, 70 per cent harbor translucent calculi."

In this particular group the surgical and pathologic findings failed to verify the X-ray diagnosis in one case. In this instance the surgeon reported a normal gall bladder and performed an appendectomy.

The outstanding associated pathology in this group was as follows: One case of cancer of the stomach and one case of abscess of the liver. There was one case of congenital absence of the gall bladder, which, because of its rarity, was not counted in this statistical study.

Of the 123 cases which had an X-ray diagnosis of pathologic gall bladder, 25, or 20.32 per cent, had faint or poor filling of the gall bladder. The surgical and pathologic findings in these 25 cases showed 24 to have a pathologic gall bladder, but in one the gall bladder was normal. In this case the patient had an inoperable carcinoma of the stomach, with metastasis to the liver. In this group the X-ray showed: Four cases with opaque stones, and four checked by surgery; seven cases with well defined mottled shadows of diminished density which were positive for translucent calculi, and seven checked by surgery. The X-ray showed 12 cases with vaguely mottled density. The X-ray diagnosis was cholecystic disease, very suggestive of translucent calculi. Surgery revealed nine cases with stones, and three cases of cholecystic disease without calculi. The X-ray showed two cases with faint shadows and no mottling, with no diagnosis of calculi: surgery revealed cholecystic disease and no calculi.

A study of this group of faintly and poorly filling gall bladders reveals that the surgical and pathologic findings verified the roentgen diagnosis of cholecystic disease in all but one case. Roentgen-opaque calculi and surgery checked. Definite shadows of mottled density, revealed in several roentgenograms, were also verified by surgery. The interesting feature in this group is that 75 per cent of the cases in which the gall-bladder shadow showed faint filling and vague mottling had translucent cholesterol calculi.

Of the 123 cases which had an X-ray diagnosis of pathologic gall bladder, 35, or 28.45 per cent, had a moderate or slight perversion of function, with or without calculi. Surgery revealed that all of the gall bladders in this group were pathologic. The X-ray showed 15 cases of cholecystic disease with no calculi: surgery revealed that one case had calculi. In this instance, the findings were those of an enlarged gall bladder, in which the cholesterol stones were flaky and floated in the bile. The X-ray showed: seven cases of opaque calculi, and seven checked by surgery; seven cases of positive diagnosis of translucent stones, and seven checked by surgery; six cases with a suspicion of translucent calculi, and surgery revealed two cases. The other four cases were: (1) pathologic gall bladder, with thick mucoid material; (2) a large thick gall bladder; (3) pericholecystic adhesions, and (4) a large gall bladder, thick walled and of the strawberry type.

Of the 27 cases which had an X-ray diagnosis of normal gall bladder, the surgical

and pathologic examinations revealed that all were normal. The findings revealed by surgery were: 14 cases of pathologic appendix; three cases of duodenal ulcers; two cases of carcinoma of the stomach; two cases of right renal calculi, and one case each of hydronephrosis of the right kidney, ulcer of the posterior wall of the stomach, carcinoma of the cecum, multiple fibroids of the uterus, pelvic adhesions to the rectum and sigmoid, and adhesions to the cecum and uterus.

A study of this group reveals that normal cholecystographic findings, when present, are of very conclusive clinical significance.

CONCLUSIONS

1. This study reveals the surgical and pathologic findings in each group of cases.
2. The roentgen diagnosis of pathologic gall bladder was checked by the pathologic and surgical findings in 98.3 per cent of the cases.
3. The roentgen diagnosis of normal gall bladder in this series was checked by the operative findings in all cases.
4. This study confirms our previous investigations, namely, 70 per cent of the cases in which the gall bladder does not fill harbor translucent calculi.
5. The error in diagnosis in oral cholecystography was 1.7 per cent.
6. The secondary reactions from the dye when taken orally are of minor importance. Most of the reactions were resultant from the laxative. However, no patients suffered clinically as a result of the examination.

DISCUSSION

DR. DAVID M. GHRIST (Glendale, California): This is the method I have followed if, after the first oral administration, I have been unable to visualize the gall bladder. Then the dye should be repeated. I have found a number of cases that have required the use of laxatives one or two days previous to repetition of the dye administration. If, after these procedures, a non-filling or non-functioning gall bladder is revealed, my report is made to that effect. I should like to ask Dr. Beilin what his usual procedure has been in this particular problem.

DR. BEILIN (closing): In our earlier work with cholecystography, we repeated a fairly large number of cases in which the roentgenograms revealed no gall-bladder shadow at the 13-, 15-, and 17-hour examinations. Our findings were the same, namely, that the gall bladder did not fill, therefore we stated that the findings were due to cholecystic disease. After checking up these cases in the operating room for several years, and noting that the surgical findings verify the X-ray diagnosis, we are perfectly satisfied that when the technic and management are carried out exactly, we are safe in saying that the findings are due to cholecystic disease to the extent of 98.3 per cent of cases.

COUTARD'S METHOD OF ROENTGENOTHERAPY AS SEEN DURING A VISIT IN PARIS[1]

Translation by H. W. HEFKE, M.D.,
Milwaukee, Wisconsin

Coutard reported, in 1928, during the International Congress of Radiology, in Stockholm, on his method of irradiation and his results in carcinomas of the upper air passages. His results were far superior to anything which others had been able to achieve in this type of carcinoma by roentgenotherapy alone; they were as good as the results at the Radiumhemmet in Stockholm by means of electrocoagulation and radium therapy. Coutard's method is used to-day in many places. The reason for reporting my impressions during a visit to Coutard's institute are two: (1) the many similarities to the school of Vienna; (2) the fact that this method is often imitated only so far as the name is concerned, but not with identical technic.

The French radiologists, under the guidance of Regaud, have employed medium and small doses in their therapy. The reason for this is that a much larger total dose thus can be given than with the single high dose technic, as used commonly by German roentgenotherapists. What is new in the method of Coutard is that it decreases markedly the hour-intensity, that is, the number of r given per hour, while the total dose is markedly increased. The single doses are very small and distributed over a long time. In this way Coutard's method corresponds in principle with the method which G. Schwarz described some time ago. The two methods differ in the manner of decreasing the hour-intensity. Coutard decreases it to about the twenty-sixth part of the average, figuring that in the average 650 r are given in 30 min. to reach a skin erythema dose. The dose which is given to each skin field during six weeks is 2,100 r; the dose effective on the tumor is 8,400 r. The decrease in the hour-intensity with 180 K.V. max. and 3 ma. is achieved by increasing the filtration to 2 mm. zinc or copper and by increasing the focus-skin distance. A practically homogeneous radiation is reached by a filtration with 1 mm. zinc, the further increase serving only to decrease the intensity. The decrease of intensity by increasing the skin-focus distance and size of field influences the depth dose favorably, as the effective dose on the tumor is increased, while the skin dose remains unchanged.

Under the above-quoted conditions the time necessary for the application of 1½–2 H (75–100 r) is about two hours. During each single treatment a field of 400 sq. cm. is given from 75 to 100 r, two such treatments being administered daily. In carcinomas of the female genitalia four fields are irradiated, two each day, for five or six weeks. The total skin dose of each field is larger than 2,100 r, as the radiation penetrating from the opposite side cannot be neglected. The total dose is more than three times larger than the skin erythema dose, when a large single dose with large hour-intensity is applied. The effective dose on the tumor is 8,400 r, thirteen times as large as the skin erythema dose. Each field is irradiated for 42 hours, the total time of irradiation being 148 hours, that is, about forty times as long as the usual time of treatment for cervical carcinomas—even longer than the time of irradiation by radium.

The biological action of such a treatment is different from the usual one, as Schwarz could show in his experiments on epilation in rabbits. In the fourth week after an irradiation amounting to 26 hours for each

[1]Dr. Blass, assistant in the Institute Holzknecht, at a meeting of the Wiener Roentgengesellschaft, January 13, 1931.

field (about 1,300 r), the skin is somewhat drier than in the non-irradiated parts and shows a little desquamation. At the end of the series one can usually see a slight folliculitis, but severe forms of radiodermatitis are rare with the present-day technic. The general reaction is slight. Roentgen sickness is seen only seldom, and then only in very stout women and to a very slight degree. The so-much-dreaded roentgen cachexia, seen sometimes after intense irradiation, is not encountered any more. The effect on the carcinoma is not decreased. The tumor gradually decreases in size or disappears, as one can see easily in cervical carcinomas. Vaginal douches with a solution of oxycyanide are given in order to prevent the resorption of destruction-products or infection.

If one compares the above-described method with the treatment used in other places under the name of Coutard's method, one sees that in most instances only the high total dose is imitated, all the rest, the decrease in hour-intensity, the duration of the treatments (lasting several weeks), and the improvement in the depth dose, are neglected. It is probable that thus the therapeutic and biologic effects are changed. If one gives six times 30 per cent of a skin erythema dose in twelve days, with a filter of 1 mm. zinc and a skin-focus distance of 30 cm. at an unchanged or only slightly decreased hour-intensity, the difference is rather clear. The effect on the skin is more marked, and erythema and edema of the irradiated fields are not infrequent. One cannot state as yet whether or not the late effects of this method are as slight as after Coutard's method. The therapeutic results are not as favorable, yet one sees with this method, though it is not a frequent observation, that tumors, which are probably radiosensitive, disappear.

The method of irradiation of tumors with single small doses and small hour-intensity, with a high total dose, administered over a long period, appears to give definitely better end-results than the methods heretofore commonly used. Because it takes much time (the single case must be treated four hours every day for six weeks) it is impossible to treat a large number of cases according to this method without upsetting the rest of the roentgenotherapeutic department. Many observations are necessary before one may give a definite statement as to when and in which localization and type of carcinoma this method of irradiation is indicated. It will be necessary to follow the above technic exactly in order to get comparable statistics.

DISCUSSION

DR. BORAK: We felt it necessary to employ Coutard's method in Holzknecht's Institute, because Coutard himself and some other men reported surprisingly good results with the Parisian method. However, the difficulty arose that our five therapy tables would have been occupied continuously by carcinoma patients, if we had used the original method. That would have meant that we could not have treated the remaining 90 per cent of the patients. As we are not an institution for the treatment of carcinomas alone, we were forced to modify the method of Coutard. Two points mainly are characteristic of it: the long duration of the series of treatments, extending over several weeks with only a small daily dose, and the long duration of the single treatments. This last fact is the one which makes the use of Coutard's method so difficult in a roentgenologic institute. We, therefore, attempted to find out if fractionating a large total dose alone would lead to an improvement in the results of irradiation therapy, and chose the following technic: A deep-seated tumor was irradiated daily with a skin-focus distance of from 30 to 40 cm., from two opposite fields, and with a dose of 200 r on each field. These treatments were given on twelve successive days, the total dose being 2,400 r per field. The skin reaction was exceedingly slight, even

though the time of the single treatment varied, according to the thickness of the filter and the milliamperage, between 10 and 15 minutes per field. The filter was sometimes 1 mm. zinc, sometimes 1.5 mm. zinc, sometimes 2.3 mm. copper—within these limits the skin reaction did not show any dependence on the filter. With the same filter thickness there seems to be no effect from different intensities (in the proportion of 1:4), practically speaking. Thus it was demonstrated that fractionating the dose alone, with some increase in filter thickness, does increase the skin tolerance considerably. The general reaction, however, was often rather marked, especially if one used larger fields than 12×12 centimeters. In some cases we discontinued the treatments for eight days for that reason, after six had been given, but increased the total dose to 3,600 r. The skin reaction was very slight, when we employed this technic. Skin epitheliomas and carcinomas of the uterine cervix were not treated with this method, because these tumors do not seem to be the ones best adapted for the test. We naturally were interested in the value of Coutard's method, not only in the case of carcinomas of the larynx, pharynx, and tonsils, which Coutard irradiated with his technic, but also in those of different localization and of more frequent occurrence; that is, inoperable carcinomas of the breast, lungs, and ovaries. The time of observation is too short to permit of making any definite statements about results; we believe, however, that one may say that Coutard's method does improve the primary result with the technic as modified by us. We saw two carcinomas of the tonsils, as well as several carcinomas of the breast and ovaries, disappear after this type of roentgenotherapy. .In several carcinomas of the lung we could demonstrate a marked decrease in size—not, however, a complete disappearance of the tumor. Irradiation of several gastric carcinomas did not give good results. We used this method of irradiation also for bone sarcomas, which otherwise have not reacted well in our experience, and saw an excellent result in one case. In three cases of recurrent lymphogranulomatosis (Hodgkin's disease) a favorable effect was noticed in that no more recurrences were noticed in the irradiated areas during the time of observation. In one such case there was no recurrence for nine months, while, previously, the tumors had recurred twice during a like period. We are at the present employing the method also in some cases of benign, otherwise more or less radioresistent, diseases, for instance, goiter, etc. We believe from our experience so far that this method of irradiation is more effective than the one which employs short and intensive treatments. Coutard's method unquestionably marks progress in the roentgenotherapeutic field.

PROF. GOTTWALD SCHWARZ: I am very interested in the matters about which Dr. Blass spoke. As generally known, I have devised a roentgen apparatus which is intended to take the place of radium treatment from long distances (the so-called "radium cannon"). The principle of this apparatus is the employment of a low tube intensity (about ½ milliampere, this naturally leading to a low number of r per minute—about 3 to 6 r per minute).

The first basic experiment, proving that the skin tolerance dose depended on the intensity of the irradiation in the meaning of Schwarzschild's law, was done by Krönig and Friedrich (1928). Freud has shown the correctness of the same law for ultra-violet irradiation. In 1924, I published experiments which showed that 10 r per minute (medium hardness of rays) and a total dose of 400 r induced only a slight erythema, with little pigmentation following it, while 40 r per minte, and the same total dose of 400 r, caused a marked reaction, with desquamation following it. One would expect, therefore, that a much higher total dose, measured in r, would be necessary to reach the permissible maximum dose, if one decreased the number of r per minute so much as is done in my apparatus, which can be connected to the house current and can be transported into the patient's room. The experience of Dr. Pape and myself as gained from patients who have been treated for Prof. Dr. Latzko, shows that irradiation with a tube intensity of 1 milliampere, giving 10 r per minute, produces twice 700 r divided by a pe-

riod of 24 hours; that is, 1,400 r, as the maximal dose. This represents threefold the usual dose. If we further decrease the number of r per minute, as I have done in previous experiments, then we approximate 2,000 r as maximal dose, as shown by Glasser and Mautz to be correct for radium. One can see that a possible increase in the maximal dose does not depend as much on the filtration as on the low intensity. Holthusen showed some time ago that the same number of r is necessary for an erythema, whether one uses 40 K.V. (unfiltered) or 180 K.V. (filtered); *i.e.*, that it is not dependent on the hardness of the rays. I agree with Dr. Borak, that by a too considerable decrease of the dose of r per minute, our treatments would be longer than it is possible to administer in our institutions. That was one reason why I devised the transportable apparatus. However, we shall finally determine an optimum of the decrease in r units per minute.

Coutard has been getting practical results for quite a long time. My own method differs from his in two respects: (1) I achieve the decrease in r units per minute by decreasing the tube intensity (not, as he does, by increasing filter thickness and focus-skin distance); (2) I employ an apparatus which can be moved to the patient and can be connected to the house current.

Dr. Borak's statement that interposing long enough pauses between the treatments is of the greatest importance, but not the decrease in the number of r units given per minute, cannot be accepted either from the theoretical or practical standpoint. It seems probable that his experiments led to these results, because his single doses of 200 r were given with an intensity of 10 r per minute as the maximum. The normal treatment with a tube current of 4 milliamperes gives 30 r per minute on the average. I have stated already that we certainly shall find an optimal dose of r per minute, below which a further decrease offers no advantage. Our experience on Prof. Latzko's patients (abdominal irradiation for carcinomas of the uterus) showed the symptoms of roentgen sickness to be very slight when a low number of r units per minute is given. This was also found to be true in a case of irradiation of the skull, while the patient had previously complained of severe headaches, vomiting, and malaise after irradiation with the usual technic.

Of great significance, of course, is the question as to whether a decrease in the number of r units per minute does not only increase the limit of tolerance for the skin but also for the tumor. Theoretically it should be true that the effect would be the greater, the greater the sensitivity of the tumor in comparison with the skin. A cauliflower-like basal-cell carcinoma of the skin, the size of a fist, remained free from recurrence after the "long time, low intensity irradiation" for a time longer than we customarily see after the usual type of irradiation. As we can get information about this question from the observation of superficially located tumors, I would recommend irradiation of such tumors with this method.

Even if this type of roentgenotherapy (low intensity and long time) should not fulfill all the hopes we have for it, the transportable therapy apparatus still will have given us a means of administering roentgen treatments in the patient's room. The absence of roentgen sickness is another advantage. I have published a more extensive paper on these problems in *Strahlentherapie* (September, 1930).

DR. R. PAPE: As an example of the influence of decreased intensity on the skin tolerance, I wish to quote a case from the series of observations of Prof. Schwarz and myself. We were able to give 1,600 r in two sittings with an interval of 3 hours, using 1 milliampere through a field measuring 15×20 cm., without getting more than an erythema, followed by pigmentation and desquamation. I do not believe that any one would dare to apply this dose to a large field with an intensity of from 3 to 4 ma., as commonly used, without fear of a severe reaction. This example shows that decrease in intensity increases the tolerance of the skin.

DR. BLASS (closing): I have not gone into the literature about Coutard's method and its biological and theoretical basis, because I wanted to report only things I had actually

seen and because the literature is known to most of you. I cannot agree with Dr. Borak, when he considers fractionating the dose as the most important feature in Coutard's method. Coutard himself considers the low hour-intensity as very essential. It appears, furthermore, from the experimental and therapeutic results, so far published, that the effect is largely dependent on the hour-intensity.

Everything I have reported to you about applying the roentgen doses I have seen personally in the institute of Coutard. The method at present in use for carcinomas of the female genitalia is not exactly the same as the one published some time ago. I must repeat again, symptoms of roentgen sickness are either absent or very slight with this method, as I observed on certain cases. Whether this type of treatment gives better end-results, or if fractional doses only also will do it—or even do it better—can be decided only after a greater volume of statistics are available, from which comparisons may be made.

A CASE DIAGNOSED BY ENDOPHOTOGRAPHY OF THE STOMACH (GASTROPHOTOR)[1]

Dr. Ehrentheil reports a case from the Krankenhaus Wieden (Section of Prof. Richard Bauer) in March, 1930. A 62-year-old teamster claims not to have been sick until two weeks previous to admission, when he showed gastric symptoms and vomiting of a mucous fluid every afternoon. Except for an emphysema and chronic bronchitis nothing abnormal was found on physical examination; no abnormal response to pressure or tenderness in abdomen. The roentgenologic findings consisted of an ulcer niche in the region of the gastric angle, with thickened mucosa folds in the same region; duodenum negative.

Examination of the gastric juice showed an anacidity. The patient, who refused operation, was dismissed after one week, without symptoms. The diagnosis was gastric ulcer; however, on account of the anacidity a beginning neoplasm was suspected and the patient was asked to come for a reexamination. Before dismissal two photographs of the inner surface of the stomach were made by means of the apparatus of Back, Heilpern, and Porges (gastrophotor). They show, especially when viewed stereoscopically, protruding and irregular masses, which, according to Ehrentheil, are diagnostic for a carcinoma. One month after the patient's dismissal from the Krankenhaus Wieden, he was operated on. At that time the vomitus had already a coffee-ground-like appearance. The epigastrium was somewhat tender, but no mass could be felt. The roentgenologic findings on April 4, 1930, were: Stomach in median position, and dilated. The secretion markedly increased; peristalsis definitely increased. After four hours the larger part of the barium is still in the stomach. There is an irregular defect in the prepyloric part of the antrum. The duodenum is negative. These findings indicate a stenosing tumor of the prepyloric part of the stomach.

A stomach resection (Billroth II) was done on April 15, 1930, the findings being a large carcinoma of the prepyloric region of the stomach, together with several enlarged lymph glands.

The pathologic report on the resected part of the stomach was: The greater curvature measures 12 cm., the lesser 4 cm.; the circumference of the resected stomach is 18 cm. on the cardiac end, 3 cm. on the pyloric end. About one cm. above the pyloric end of the resected stomach there is a deep depression. The serosa is definitely thickened and granular in this area. Corresponding to this there is a crater, about the size of a quarter, on the mucosa side, its edges fairly sharp and thickened. The base of the ulcer is formed by a whitish, hard, slightly granulated tissue, which penetrates into the surrounding tissue without definite demarca-

[1]Meeting of Wiener Gesellschaft für Roentgenhunde, January 13, 1931: Chairman, Prof. Holzknecht; Secretary, Dr. Presser.

tion on a cross-section. The other mucosa folds are thickened and edematous. Histologically there is a peptic ulcer, on the base of which a granulation tissue with many vessels can be seen. It has changed to fibrotic tissue with thick-walled vessels in some places. Towards the outside, lobules of fatty tissue are pulled into the scar. This area and the surrounding parts of the muscularis propria and especially of the submucosa are infiltrated by an adenocarcinoma. In the mucosa limiting the ulcer only a few carcinomatous areas can be seen. There is an atypical regeneration of glands on the edge of the ulcer. The macroscopical prominence of the ulcer edges is caused mainly by the carcinomatous infiltration of the submucosa. One is, therefore, dealing with a carcinomatous ulcer.

From the charts and findings one can see that the differential diagnosis between ulcer and carcinoma remained doubtful in this case up to the time of operation. The different findings by the pathologist can probably be best explained by the difference between a living stomach and a post-operative specimen. Such protruding, irregular masses have been seen only in carcinomas, and one must in the future continue to diagnose a carcinoma in similar instances of gastrophotography. The question remains open, whether or not these irregular masses were tumor tissue or if one was dealing with certain vital changes in the carcinomatous stomach which were no longer visible after the death of the tissue.

DISCUSSION

DR. F. EISLER: If one wishes to answer the question as to the extent to which Dr. Ehrentheil is right in reporting this case in favor of gastrophotography, one must discuss in detail the roentgenologic findings. As one sees in the film, there is a rather extensive ulcerative process in the neighborhood of the pylorus. This should make one think of a malignancy, as I maintained in a discussion following a paper of Haudek's some years ago. The study of the details in this case, however, makes me refrain from reporting—as is usual in such cases—"ulcerative process, malignancy cannot be excluded," and causes me to decide in favor of an ulcer, especially as the surgical department has planned an operation in either case. The X-ray films show a perfectly smooth ulcer base and edges and only slightly thickened parallel mucosa folds, without irregularities in the granular appearance such as we find in tumors, which infiltrate the submucosa for a distance from the edge of the ulcer. These roentgenologic findings were confirmed by the pathologist. The macroscopic inspection showed a peptic ulcer with sharp edges, and only histologic examination gave evidence of a tumor. Under these circumstances one must ask how the gastrophotogram, which can show only the condition of the mucosa, could make another diagnosis possible. One could possibly explain it by the fact that the inflation of the stomach with air stretched the elastic portions only, and not the fixed ulcer, which then protruded tumor-like into the gastric lumen. An advantage of the gastrophotogram over the roentgenogram cannot be admitted, especially since the diagnosis of neoplasm had already been made.

At this time I wish to report briefly my findings, gained from some dozen gastrophotograms, which were partly checked by roentgenologic examination. One cannot recommend this method for general use for the reason that its technic is rather bothersome to the patient and that it must be repeated often. The photograms, furthermore, do not always give a view of the entire inner surface of the stomach. It may happen that a lesion may be present in a part not shown. I believe that only selected cases should have gastrophotograms made, and that these cases should have already been examined roentgenologically. To this group would belong, in my opinion, stomachs with a diffuse hypertrophy of the mucosa, such as might obscure small circumscribed lesions (for instance, ulcers) during the roentgenologic examination.

Also a gastrophotogram of the posterior wall of the fundus would sometimes be of help, as the compression necessary for details can often not be applied in this region (cascade stomach, etc.).

PROF. HAUDEK:[2] Naturally the roentgenologist would welcome the help of gastrophotography, if it really would give added information in cases in which an experienced roentgenologist has difficulty in reaching a conclusion. This has not been proven. The case reported by Dr. Ehrentheil does not change my opinion. I cannot agree, after examining the roentgenograms, that this is the appearance of a typical niche and that the conclusion can be arrived at that one is dealing with a deep prepyloric ulcer. The film does not show a perfectly typical niche, protruding from the lesser curvature, but it does show a large crater filled with contrast medium just below the lesser curvature. Agreeing that transverse gastric folds seem to run to this crater, one must not consider this sign wholly reliable; the folds of the intact mucosa might simulate it by overlapping. The rather extensive crater is by no means sharply outlined. One sees, furthermore, a concave negative shadow closer to the greater curvature, reminding one of a filling defect, but also explainable by the irregular pressure of the compressing spoon. From the roentgenograms a carcinomatous crater as well as an ulcer could be diagnosed. Indeed, four weeks afterwards a filling defect could be demonstrated in the Clinic Eiselsberg, which made possible the diagnosis of a tumor, verified by operation.

This case does not seem to offer a reason to change our opinion that the gastrophotographic examination cannot be considered superior to roentgenography or that it may add something of value to the diagnosis.

DR. F. EISLER: It was not to be expected that the roentgenologic findings would be agreed to by everyone. The wall surrounding the ulcer, which Prof. Haudek considers the sign of a tumor, is in my opinion not a definite differential diagnostic sign; it may represent an inflammatory reaction around a peptic ulcer. I still believe that the neoplastic character of the ulcer could not be diagnosed, especially if one considers the regular and normal appearance of the mucosa folds. The case shows that, even with a careful examination and observation of all details, roentgenologic differentiation between a benign and a malignant ulcer is not always possible. Concerning Prof. Haudek's remarks about the "mucosa diagnosis," I should like to call attention to the paper published, with Lenk, in 1921, "The Importance of the Roentgenologic Appearance of the Gastric Mucosa for the Diagnosis of a Gastric Ulcer" (*Deutsche med. Wchnschr.*, 1921, Heft 48). If one reads this paper he may perhaps be convinced that it furnishes the method and partly also the diagnostic basis for the relief examination, which nowadays is considered so important. Anyone who has had occasion to see us examine stomachs roentgenologically knows that we always have paid very considerable attention to the state of the mucosa. Since the publication of that paper the convergent mucosa folds have been shown to be an especially valuable sign, which makes a diagnosis possible, especially when a niche is not present.

DR. PRESSER analyzed the roentgenologic findings in this case and concluded that at least a suspicion of neoplasm should be acknowledged on account of several details (step-like kink above the niche, some irregularities and narrowing of the mucosa folds).

DR. EHRENTHEIL (closing): Endogastric photography is hardly more uncomfortable to the patient than a gastric lavage. Even if this method shows less in the average case than does the roentgenologic examination, it is indicated in certain cases, if it can show more than the roentgenologic examination even in only a few cases. The explanation which Dr. Eisler gave for the plastic protrusion of the pathologic area in the gastrophotograms makes clear the difference between the gastrophotographic and the macroscopic-pathologic findings. It is caused by inflation of the stomach with air before the photogram is taken, and the infiltrat-

[2]Died March 9, 1931.

ed portions of the stomach, which are not so elastic as the normal parts, protrude definitely into the gastric lumen.

MYOMAS OF THE ESOPHAGUS

Two cases of myoma, with roentgenologic findings, were reported by R. Pape (assistant to Prof. Gottwald Schwarz) and Dr. Spitznagel (pathologist).

Case 1. A 64-year-old woman complained of fever for four weeks, hemoptysis, and a swelling the size of a prune under the left breast. No lung symptoms except dyspnea. Five years previously a hypernephroma of the left kidney had been removed surgically.

Roentgenologic findings: The right upper lobe showed increased density; in the corresponding hilum there was a definite, enlarged, infiltrated lymph gland the size of a nut. An osteoclastic metastasis corresponded with the tumor under the left breast. Posterior to the stomach one could see a movable calcified tumor something less than an inch in diameter. The lower portions of the esophagus were somewhat dilated and showed several well circumscribed filling defects of about the same size as the tumor mentioned above, which were plainly visible when compression was used in the epigastrium. There was only a slight and temporary stasis in this part. The mucosa was intact.

The infiltration in the upper lobe was considered to be secondary and metastatic from the renal carcinoma and was explained as being pneumonic-atelectatic, caused by obstruction of a bronchus by large hypernephroma metastases in the corresponding hilum. The filling defects in the lower third of the esophagus were also thought to be metastases in lymph glands compressing the esophagus. Bronchography, which was advised, was not done on account of the increasing cachexia of the patient.

The autopsy findings (Dr. Spitznagel) were as follows: No evidence of a hypernephroma. There was a bronchial carcinoma with interlobar, mediastinal, and bone metastases. The changes in the esophagus were due to an irregular, lobulated tumor, 6 cm. in length, originating in the wall of the esophagus; it consisted of multiple small leiofibromyomas, protruding into the lumen of the esophagus and connected with one another. The calcified tumor posterior to the stomach was a totally calcified, subserous tumor of the posterior wall of the stomach, also a myoma. There were, likewise, numerous fibromas and lipomas of the skin.

The principle of explaining all symptoms from one etiologic cause proved to be false in this case (see Max Sternberg, The Importance of the Scholastic Philosophy for the Modern Medical Thinking, *Abhandlungen der Theoretischen Biologie,* 1926, XXIV). In case of doubt one should decide rather against than with this principle. Also, the presence of six different primary tumors, two of them different malignant tumors, is remarkable.

Case 2. This case was seen in the Sofienspital, the roentgenologic examination being done by Dr. Klima, who kindly allowed us to publish it. A 68-year-old man suffered from severe dyspnea, the breathing of obstruction type. There were no definite difficulties in swallowing.

Roentgenologic examination showed the presence of a mass the size of an apple retrosternally and to the right of the trachea, which was somewhat displaced toward the left, and narrowed. This mass was situated just above the arch of the aorta, like a substernal goiter. As there were no symptoms of dysphagia, the esophagus was not examined by means of a barium mixture.

During the operation (Hofrat Ewald) both lobes of the thyroid were removed, but surprisingly, no marked amount of enlargement of the thyroid was seen. A tracheotomy had to be done, because the dyspnea remained very severe after the operation,

which gave only temporary alleviation. Death took place three days later.

During the autopsy (Dr. Spitznagel) a fibromyoma of the esophagus the size of a child's fist was found to be the cause of the stenosis of the trachea. It originated from the posterior wall of the thyroid cartilage and filled the upper third of the esophagus. The trachea was narrowed from behind and showed signs of a malacia. Interesting is the note in the patient's chart, that he preferred to have his head bent backward as much as possible (that apparently prevented the heavy tumor from pulling on the larynx). He probably could have been saved if a correct diagnosis had been made.

A roentgenologic diagnosis of myoma of the esophagus is possible. The smaller myomas differ from carcinoma by the absence of infiltration of the wall and the smooth contour of the mucosa; they are differentiated from mediastinal lymph glands leading to compression phenomena by the fact that they are close to the mucosa (sharp edges, demonstrable *en face*). Large polypoid myomas can be recognized by the fact that the contrast medium flows around them, the continuous band of the contrast shadow being split, while it stays constant and continuous in the case of a substernal goiter, which might displace it entirely. Also, a carcinoma usually shows only one fixed narrowed canal. If one sees a large, atypical filling defect, one should always think of a polypoid growth. One should, furthermore, always examine the esophagus with a barium mixture in case of a substernal goiter, even if there are no symptoms of dysphagia. In the case of large tumors the correct diagnosis might save the patient's life. With small tumors, the diagnosis of metastatic malignant lymphatic glands compressing the esophagus might be wrongly made. These two cases of esophageal myoma are, so far as we know, the first ones observed roentgenologically.

PROCEEDINGS OF THE SWISS RADIOLOGICAL SOCIETY[1]

Translation by H. C. Ochsner, M.D., Indianapolis, Indiana

Prof. Claude Regaud: *Radiophysiological Principles of the Radiotherapy of Cancer.*—An investigation and proper understanding of radiophysiology are no less essential to the progress of radiotherapy than the study of physical principles and the perfection of instrumental technic. The normal and cancerous tissues of man have a common radiophysiology. Substances such as vegetable cells, bacteria, and lesser animals have, in common with human tissues, only the most elementary properties of living matter, and consequently conclusions drawn from a study of the effects of radiation on such cells may be erroneous when applied to man. The direct effect of irradiation is far more important than the indirect effect. Perfect radiotherapy utilizes the variation of radiosensitivity in cancerous and normal tissues. There are great variations in the radiosensitiveness of different tumor types, but it is impossible to designate a dose curative for carcinoma, sarcoma, etc. The author describes clinical methods of radium and roentgen therapy.

Dr. Voegeli: *Idiopathic Dilatation of the Esophagus.*—Report of two cases, with the symptom-complex of esophageal stenosis, that, on X-ray examination, were found to have an idiopathic dilatation of the esophagus. The author reports the explanation of the etiology of this condition advanced by various authors. An attempt has been made

[1] Translation of abstracts of papers published in *Schweizerische Medizinische Wochenschrift*, 1930, LX, 1217.

to explain the condition by analogy to dilatation of the colon, hydrops of the gall bladder, and hydronephrosis. He concludes that idiopathic dilatation of the esophagus is due primarily to lack of normal tonus.

DR. FEISSLY: *Dystopias of the Colon.*—For an understanding of the malformations of the colon it is necessary to study the embryological development of the digestive tract. An arrest of torsion may produce: (1) Congenital retroposition; (2) sinistrocolon due to an arrested rotation at 90°, 180°, or 270° (in these conditions the common mesentery persists); (3) situs inversus. The most frequently observed anomaly is non-descent of the cecum. In cecum mobile the cecum is normally descended.

DR. WALTHER: *Roentgen Examination of Recruits in the Swiss Army.*—In a series of 20,000 examinations of men liable to service, symptoms of chronic tuberculosis were found. In from 4 to 5 per cent of recruits who had passed previous examinations there were roentgenologically demonstrable signs of pulmonary tuberculosis. Wiewiorowski, in an examination of the German police, found a similar percentage of infection (4.3 per cent). The lesions are chiefly of the indurative type and involve both apices in 50 per cent of the cases. The value of roentgen examination is shown by the lessened incidence of later development of tuberculosis during the period of military training.

DR. ROSSELET: *Roentgen Therapy of Sciatica.*—The similarity of results obtained by the use of rays of very long or very short wave length leads the author to believe that the effect of such radiation is largely due to cutaneous absorption of energy.

DR. SCHINZ: *Radiotherapy.*—Roentgen and radium therapy are based upon physical and biological principles and hence physical and biological experiments must go hand in hand with clinical and therapeutic investigations. The author reports experimental findings in a study of the radiosensitivity of the structures of the eye and of radionecrosis of bones. He discusses the problem of the specific character of radiation and the methods of treatment, as well as the result obtained in experimental work with thallium, lead, and Coley's serum.

CASE REPORTS AND NEW DEVICES

REPORT OF A CASE OF ROENTGENOLOGICALLY DEMONSTRABLE ESOPHAGEAL VARICES COMPLICATING SPLENOMEGALY[1]

By B. R. KIRKLIN, M.D.,
Section on Roentgenology,
and
HERMAN J. MOERSCH, M.D.,
Division of Medicine,
The Mayo Clinic,
ROCHESTER, MINNESOTA

Varices of the esophagus are by no means uncommon, but the case reported here is deemed worthy of record because the varices were incident to splenomegaly, were extraordinarily large and extensive, and were readily demonstrable with the roentgen ray.

The patient, a man, aged 26 years, came to The Mayo Clinic because of recurring hematemesis and melena. The first attack occurred in November, 1927; the last in October, 1930. Every attack was preceded for about two weeks by a tickling sensation in the throat which gave rise to coughing, but this ceased immediately after the vomiting of blood, which always occurred suddenly. Other than this the patient had never had any gastric symptoms. His personal history was negative for alcohol, syphilis, or serious antecedent disease. He was five pounds under his usual weight.

On general examination the patient appeared to be anemic and was definitely icteric. The abdomen was distended and the spleen was palpably enlarged. The temperature was 99.2°; the pulse, 115; the systolic blood pressure, 135, and the diastolic, 80. The hemoglobin was 6.4 to 7.75 gm. for each 100 c.c.; erythrocytes numbered 3,370,000, and leukocytes 2,800 to 3,100. The percentages of leukocytes were as follows: lymphocytes, 25; monocytes, 7.0; neutrophils, 65.0; eosinophils, 1.0, and basophils, 1.5. Reticulated cells were 2.4 per cent. Platelets numbered 136,000. The coagulation time was four minutes. Moderate poikilocytosis, hypochromasia, and anisocytosis were present. The blood urea was 26 mg.; the serum bilirubin was 2.7 to 3.8 mg., and the van den Bergh reaction was indirect. Fragility of the erythrocytes was normal. A test of the function of the liver showed retention of dye, graded 2. The Wassermann reaction of the blood was negative. The fractional test meal gave negative results.

A roentgenologic examination, without knowledge of the clinical history, was made January 16, 1931. When the first swallows of the thin aqueous suspension of barium were taken, the esophageal lumen from a point just below the level of the aortic arch to the hiatus first appeared as a narrowed tortuous canal with marginal defects which suggested the multiple intrusions of a malignant neoplasm. Then the mixture penetrated the crevices between the intruding masses and depicted a lumen of normal or greater than normal width in which were many shadow defects resembling those produced by particles of food in a case of low esophageal obstruction. But the barium passed into the stomach without delay, and on closer inspection it was seen that the transradiant defects were rounded and permanent in situation. Obviously, the masses were more or less polypoid, and as they were precisely similar in size and appearance to gastric or intestinal polyps it was difficult to avoid the conclusion that the case was one of esophageal polyposis (Fig. 1). However, after conferring with the clinician and learning of the history of severe hematemesis and of the enlargement of the liver and the

[1]Submitted for publication April 2, 1931.

Fig. 1. The varices are depicted as rounded transradiant areas distributed in the barium shadow from the middle of the esophagus to the hiatus.

spleen, it became evident that the polypoid masses were not adenomatous but venous.

Esophagoscopic examination, January 21, disclosed multiple varicose veins beginning in the middle third of the esophagus and extending downward. They formed large, bluish, nodular prominences which were soft and compressible and resembled varicose veins of the leg (Fig. 2). Danger of inducing hemorrhage forbade any attempt to carry the examination into the lower portion of the esophagus.

The correlated clinical diagnosis was primary splenomegaly, with secondary cirrhosis of the liver, and huge esophageal varices and secondary anemia from loss and destruction of blood.

At operation, February 4, the spleen was removed. It was eight or ten times larger than normal, with enormously enlarged veins in the adhesions to the posterior abdominal wall; the veins at the hilum were dilated. Grossly, the liver had only a slight amount of additional connective tissue, with no definite evidence of cirrhosis. The coronary veins were not greatly distended and were not ligated. The spleen weighed 800

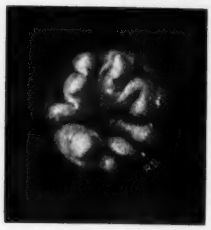


Fig. 2. Endoscopic view of the varices at the upper limit in the middle third of the esophagus.

grams. Marked splenitis with perisplenitis, splenic anemia, and progressive Banti's disease were present.

February 23, after the patient had recovered from the operation, he was re-examined. The roentgenoscopic and roentgenographic appearance of the esophagus was identical with that observed before operation (Fig. 3).

Apparently few cases have been recorded in which esophageal varices were demonstrable with the roentgen ray. Jackson[2] and his associates reported an instance of varices confined to the subdiaphragmatic portion of the esophagus, and roentgenologic examination disclosed obstructive narrowing of this segment but no typical defects. However, two cases were reported by Wolf[3] in which the roentgenologic phenomena were almost identical with those which we observed. In both of Wolf's cases the varices were secondary to cirrhosis of the liver.

Clinically our case again emphasized the

[2]Jackson, Chevalier, Tucker, Gabriel, Clerf, L. H., Lukens, R. M., and Moore, W. F.: Hematemesis; a Plea for Objective Methods of Diagnosis. Jour. Am. Med. Assn., Sept. 19, 1925, LXXXV, 870-874.

[3]Wolf, Günther: Die Erkennung von Osophagus-Varizen im Roentgenbilde. Fortschr. a. d. Geb. d. Roentgenstrahlen, 1928, XXXVII, 890-893.

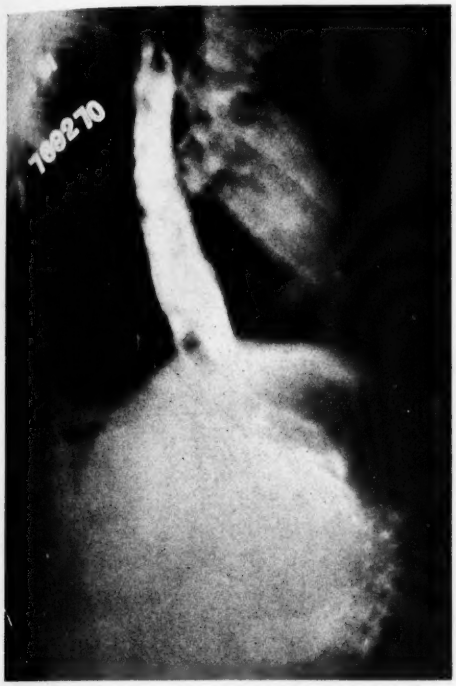


Fig. 3. Roentgenogram of esophagus nineteen days after operation.

necessity of considering the esophagus in tracing the source of hemorrhage from the alimentary canal. When the least doubt exists as to the origin of the bleeding, the esophagus should be examined thoroughly, both with the roentgen ray and the esophagoscope. In a review of twenty-six cases of advanced portal cirrhosis, McIndoe[4] found that hemorrhage was the cause of death in 50 per cent. When esophageal varices are discovered, it is self-evident that the patient's diet should be restricted to foods that will not traumatize the varices or tend in any way to produce inflammatory reaction about them and thus induce bleeding. Further, the demonstration of varices in the esophagus may establish an earlier diagnosis and lead to prompt surgical interference with the prospect of greater benefit.

[4]McIndoe, A. H.: Vascular Lesions of Portal Cirrhosis. Arch. Path., January, 1928, V, 23-40.

AZYGOS LOBE OF THE RIGHT LUNG

By S. BROWN, M.D., and M. BRAVERMAN, M.D.
From the Departments of Roentgenology and Pathology, Jewish Hospital,
CINCINNATI, OHIO

The peculiar inverted comma-like shadow occasionally seen in the right upper lobe remained a puzzle to roentgenologists until the postmortem studies of Bendick and Wessler (1) determined the exact nature of this anomaly. Recently we have had an opportunity to make a postmortem examination of a patient with an azygos lobe which differed in some respects from those of other observers. Instead of an inverted comma-like line alone, the area corresponding to the usual position of the azygos lobe was found to consist of a uniformly dense shadow suggesting consolidation, but which proved upon examination to be free from any abnormal changes.

G. C., male, aged 81 years, entered the Jewish Hospital suffering from a rapidly progressing arteriosclerotic type of gangrene of the left lower extremity. On the eighth day post-admission the symptoms and signs

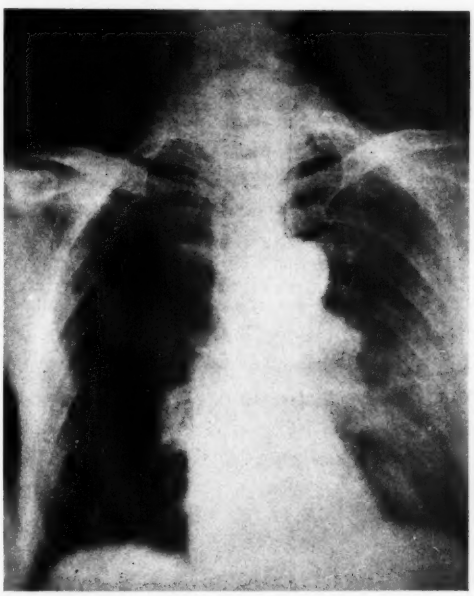


Fig. 1. Azygos lobe of the right lung.

Fig. 2. Attempt at postmortem injection of the tracheobronchial tree of right lung as well as the azygos lobe.

of a hypostatic pneumonia developed, more marked in the left lung. Roentgen examination of the chest (Fig. 1) revealed a pneumonic consolidation of the left lung, and, also, a dense shadow of the right upper lobe to the right of the trachea and delineated by a sharp border laterally. The shadow was thought to be due to one of several conditions, namely, azygos lobe, pleuritic thickening around the apex, substernal thyroid, aneurysm, or local pneumonic consolidation. The necropsy demonstrated this to be due to an azygos lobe (Fig. 2). No pathologic findings were revealed in the lobe.

A note of thanks is due to Dr. M. Herzberg and Dr. J. Goldstein, of the Jewish Hospital Department of Pathology, for their kind assistance.

REFERENCE

BENDICK, ARTHUR J., and WESSLER, H.: Azygos Lobe of the Lung. Am. Jour. Roentgenol. and Rad. Ther., July, 1928, XX, 1-6.

A LITHOPEDION: CASE REPORT

By HOMER W. GRIMM, B.S., M.D.,
PITTSBURGH, PA.

The patient, Mrs. M. B., gave birth to a normal child when twenty-four years of age. When twenty-six years of age she went through an eight-months pregnancy. The membranes ruptured, with a bloody discharge which lasted for three days. One month later the menstrual periods were re-

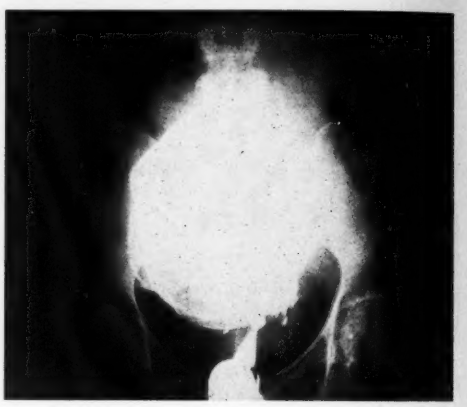


Fig. 1. Injected uterus, showing tumor to be extra-uterine.

sumed and continued normally until sixteen years previous to the present examination, when the patient experienced a normal menopause.

Three days prior to entering St. Mar-

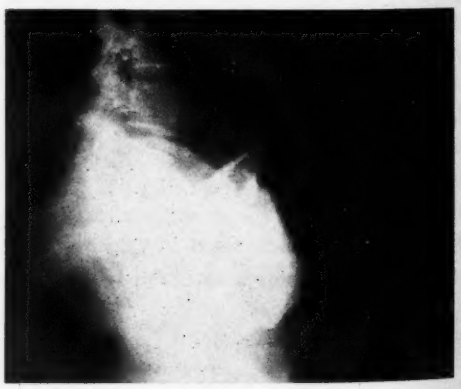


Fig. 2. Lateral view.

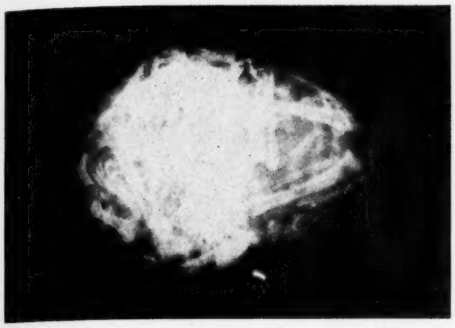


Fig. 3. Specimen after removal.

garet's Hospital, Pittsburgh, there was a mass palpable in the pelvis. An iodopin injection into the uterus and an X-ray examination revealed that it had the characteristics of an extra-uterine tumor, with outlines of fetal structures encased in a calcified exterior. This mass was removed surgically.

BILATERAL TRAUMATIC PNEUMOTHORAX, WITH RECOVERY

By L. R. LINGEMAN, M.D., and
WALTER FENSTERMACHER, M.D.

From the Departments of Radiology and Surgery of the Rochester General Hospital, ROCHESTER, N. Y.

Cases of traumatic bilateral pneumothorax, with recovery, are sufficiently rare to warrant the reporting of this case.

The patient, A. S., Case No. 53,975, age 13, was admitted to the surgical service July 30, 1929.

Chief Complaint.—Injury to back; difficulty in breathing.

Family History.—Irrelevant.

Past History.—Irrelevant.

Present Illness.—While assisting to put up hay the patient was struck in the back by a hay fork which had been dropped from a load of hay. There were no immediate symptoms except pain. The patient was immediately started for the hospital, but before arriving, swelling of the left neck and chest was noticed.

Physical Examination (three hours after injury).—The patient was a well developed and nourished lad, white. He was sitting upright in bed and experiencing considerable difficulty in breathing. There was no cyanosis. Two puncture wounds were seen at the level of the third intercostal spaces posteriorly, one on either side of the spine. Subcutaneous emphysema extended upward across the back, involving the neck and face on the left side. It was not quite so extensive on the right side. *Head:* Negative. *Eyes:* Reacted to light and accommodation —negative. *Ears:* Negative. *Nose:* Nostrils dilated with inspiration. *Throat:* Negative. *Neck:* As above. *Chest:* Right chest was nearly motionless. Patient was breathing with the left chest and abdominal muscles. The rate was 36. There was an expiratory grunt. The entire right chest was tympanitic; breath sounds were absent except at the base. The left chest was hyperresonant; the breath sounds were obscured over the emphysematous areas, but

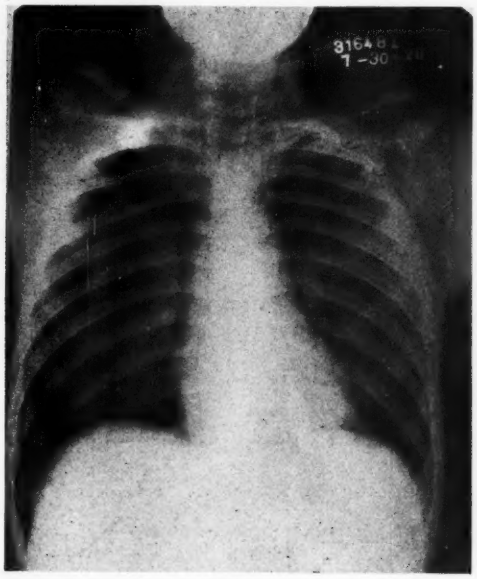


Fig. 1. There is a large pneumothorax involving the right side and a very small one at the left apex. No displacement of the mediastinum.

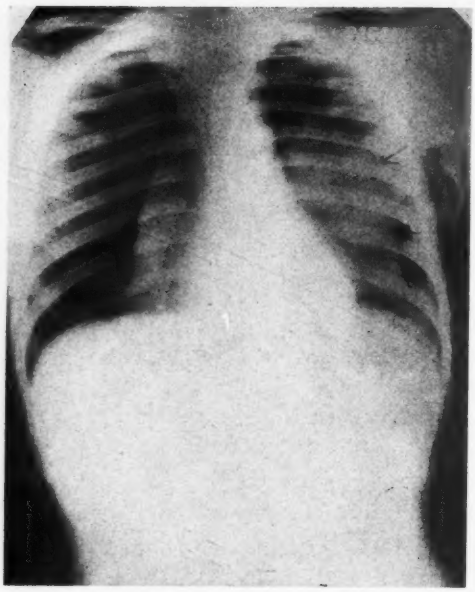


Fig. 2. Film made 24 hours after the injury. There is complete collapse of the right lung and about two-thirds collapse of the left.

were heard at the axilla and at the base. *Heart:* Blood pressure 90/64; apex in the fifth intercostal space 9 centimeters to the left of the mid-line. *Abdomen:* Negative. *Extremities:* Negative. *Reflexes:* Negative. *Blood count:* 4,020,000 (red); 11,600 (white); hemoglobin 75 per cent; blood Wassermann negative. *Urine:* Negative. *Temperature:* 99.6. *Pulse:* 100.

At this time an X-ray examination of the chest showed a pneumothorax involving about two-thirds of the right side and a very small pneumothorax involving the apex of the left side (Fig. 1). There was also an extensive subcutaneous emphysema involving the soft tissues of the neck on both sides and the left axilla. The heart and structures of the mediastinum were not displaced.

Progress.—The patient's condition became worse. The dyspnea increased. Respirations were 40 and were labored. There was definite cyanosis of the fingers. The subcutaneous emphysema increased and involved the entire chest anteriorly, the neck and arms.

At this time (four hours after injury) 700 c.c. of air were aspirated from the right chest by reversing the bottles on the pneumothorax box. The initial reading was plus 12—plus 8; final reading was minus 8—minus 10 centimeters of water. This was followed by great improvement in the patient's condition. Respirations dropped to 20; the color improved; there was much less dyspnea.

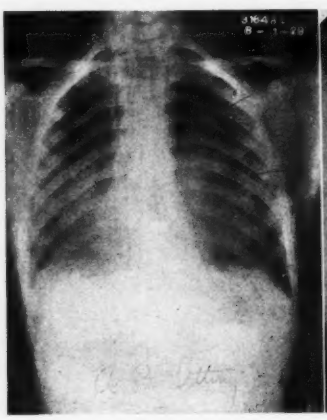


Fig. 3. Film made 48 hours after the injury. There has been considerable re-expansion of the right lung.

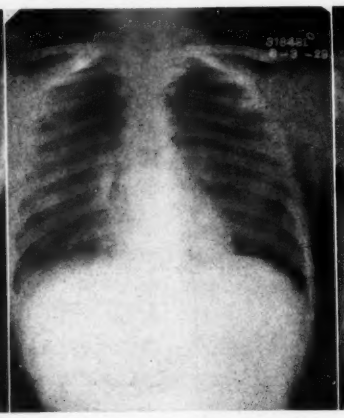


Fig. 4. Film made four days after the injury. The right lung has re-expanded; still some collapse of the left lung.

Fig. 5. Shows both lungs completely expanded.

On July 31, the day after admission, the subcutaneous emphysema had involved the entire back. No heart or breath sounds could be heard. Blood pressure was 86/60. There was moderate dyspnea and slight cyanosis.

An X-ray examination at this time showed complete collapse of the right lung and two-thirds collapse of the left lung (Fig. 2). At this time 800 c.c. of air were aspirated from the right chest, using the pneumothorax box as before. This caused the disappearance of the dyspnea and cyanosis. Repeated observations and X-ray check-ups showed a gradual expansion of the lungs, and the patient was discharged on the sixteenth day with a small pocket of air in the left chest. An X-ray examination made one month after admission showed complete re-expansion of the lung.

COMMENT

1. This case illustrates the necessity for early and frequent roentgenologic and clinical examinations in chest injury cases to determine the extent and progress of the pneumothorax.

2. This case also illustrates the value of prompt aspiration of air from the pleural cavity in progressive lesions of this type.

3. It demonstrates the facility with which air can be aspirated from the pleural cavity by simply reversing the bottles of the pneumothorax instrument.

COMMON BILE DUCT EMPTYING INTO DUODENAL DIVERTICULUM

CASE REPORT

By CARL BENNINGHOVEN, M.D., and PAUL MICHAEL, M.D.
Departments of Roentgenology and Pathology, University of California Medical School, San Francisco, California

The etiology of duodenal diverticula still remains a disputed question. Keith felt that the lesions were acquired because of traction from without, as adhesions following gallbladder disease or pancreatitis. The case here reported is of interest because it presents the combination of a duodenal diverticulum, caused apparently by the traction of adhesions about the common bile duct and the duodenum, and secondly, because of rather prominent longitudinal markings in the lower third of the esophagus, which proved to be varicosities.

History.—The patient was a male, Italian farmer, aged 53. He entered the hospital with a complaint of intermittent dull pain in the epigastrium and left upper quadrant, which dated back about one and one-half years. The pain was accentuated by food and not relieved by ordinary medical remedies. The attacks would start in the mid-epigastrium, radiate to both upper quadrants, and were sufficiently severe to double the patient up. They were accompanied with nausea but no vomiting except on two occasions, one just before, and a second two weeks after, entry into the hospital, when the patient vomited about one pint of bright red blood. His stools had been tarry on several occasions. Within the month previous to entry the patient had lost about 15 pounds in weight. His past history and family history were negative except for the habit of drinking wine with all meals.

Physical Examination.—The mucous membranes were pale. The lung findings suggested emphysema. The heart sounds suggested a mitral insufficiency and the vessels were markedly sclerotic. Throughout the upper abdomen there was definite guarding and tenderness. On deep palpation an indefinite mass was felt across the upper abdomen. The laboratory findings revealed a moderate secondary anemia and a leukopenia. The stools gave a markedly positive

Fig. 1. Note the duodenal diverticulum and the esophageal varices.

guaiac test while on a meat-free diet. The Rose Bengal liver function test showed evidence of liver damage.

At this time it was felt that the patient's disease was carcinoma of the stomach, with metastases to the liver, consequently a roentgen examination of the gastro-intestinal tract was made. There was a definite but slight dilatation of, and delay in, the lower part of the esophagus. Markings, simulating those of rugal lines, were more definite than usual in the lower end of the esophagus. The cardiac end of the stomach showed some hypertrophic rugæ. Peristalsis passed completely over the usual portions of the stomach. The duodenal bulb was quite large and was definitely indented in the apical region. The posterior part of the first portion of the duodenum appeared to be somewhat lower than normal, relative to the cap. There was a large bilobed diverticulum extending to the left of, and slightly anterior to, the lower third of the descending portion of the duodenum. At six hours the stomach and diverticulum were empty. The remainder of the tract was not remarkable.

Pathological Report.—"The liver is granular, firm, and atrophic, and weighs 1,000 grams. It is brick-red in color and on cut section shows an increased fibrosis. Microscopically it is not a typical portal cirrhosis as there is excessive cellular and acellular fibrous tissue and a coincidental infiltration of small round cells. The gall bladder is small and compressed and has a thickened wall. It is gray in color. Bile can not be expressed into the duodenum by pressure on the gall bladder. On opening the gall bladder a fibrous band is seen which obstructs the opening into the cystic duct. The common duct is dilated. It has a greatly thickened wall and contains a small amount of inspissated bile on the mucosa. The common duct is covered by fairly dense adhesions and empties through the ampulla of Vater into a large diverticulum about two and one-half centimeters in diameter. This latter opens into the duodenum proper by a wide neck. The wall of the diverticulum is inelastic. It contains all the layers of the intestine plus many adhesions in the outer covering. The esophagus is markedly dilated, having a diameter of about two and one-half centimeters. The wall itself is thickened and there are many large esophageal varices running longitudinally, especially marked in the lower half of the esophagus. These vessels are dilated, tortuous, and show areas of recent hemorrhage. The stomach is dilated and attached to the spleen by many adhesions. The wall appears thickened and contains many varices. The mucosa contains many engorged vessels and shows several areas of recent hemorrhage. The pylorus is normal, and the duodenum is dilated.

"The pancreas shows a distortion of the normal markings. There is a definite necrosis of cells and an increase of fibrous tissue. The cell islets are well preserved in most instances. There is also an accompanying fatty infiltration. The pancreas presents the picture of obstructive pancreatitis."

Summary.—A case having the common

bile duct emptying into a duodenal diverticulum is presented. Although simple duodenal diverticula are by no means uncommon, one of this type with the coincident findings was thought to be of sufficient interest to report. From the foregoing description it can be assumed that the adhesions about the gall bladder, common bile duct, and duodenum could have formed this true diverticulum by traction. The coincidental varicosities of the esophagus are of interest, but their diagnosis was given only after due consideration of the clinical history.

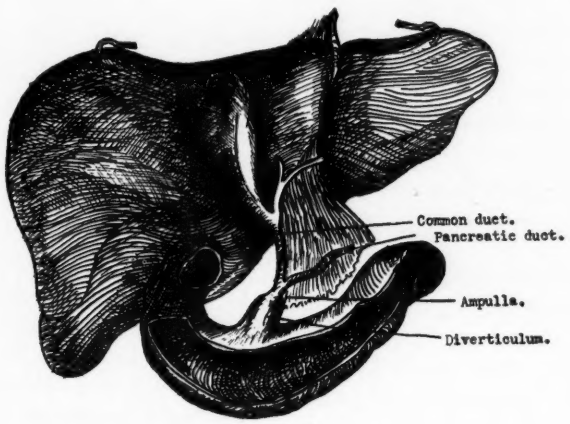


Fig. 2. Semi-diagrammatic representation of the diverticulum of the duodenum (pancreas removed). (Paul Michael.)

A NEW METHOD FOR STUDYING CHEST FILMS

By HAROLD G. F. EDWARDS, M.D., F.A.C.P.,
SHREVEPORT, LOUISIANA

In the belief that anything which improves the diagnostic value of chest roentgenograms is welcome, the writer presents a new and novel method for their study, especially those made at a distance of six feet or more.

The film to be examined is placed in the usual viewing box, with the usual lighting intensity. A pair of opera glasses with lenses of the highest quality are used for the study of the film, the observer being fifteen to twenty feet distant from the film, with the glasses properly focused. At once one will be amazed at the wealth of contrast, detail, and depth revealed when the film is examined in this manner. Better films are made of poor ones by the contrast and plastic effect brought out by the use of the opera glasses—it is no delusion.

The method is especially desirable for the study of films displayed at meetings, since it permits those at a distance from them to see full detail.

In so far as I know, the method here advocated has not appeared in the literature.

EDITORIAL

LEON J. MENVILLE, M.D. . . . *Editor*
BUNDY ALLEN, M.D. . . *Associate Editor*

Contents of RADIOLOGY copyrighted by the Radiological Society of North America.

THE NATIONAL INSTITUTE OF HEALTH

One of the most important items of interest to the medical world in recent years was the passage of a bill by Congress, in May, 1930, creating the National Institute of Health, now located in Washington, D. C. It will serve as the research center of the Public Health Service. Its duty is to study the cause, prevention, and cure of every disease of man. The passage of this bill serves to proclaim to our people the beginning of the greatest crusade against disease the world has ever known. This is to be accomplished by scientific research conducted by the most eminent scientists connected with plant and animal life in every part of the world.

The author of the bill creating the National Institute of Health is Hon. Joseph E. Ransdell, former Senator from Louisiana, who is perhaps as well known for his great interest in health matters as he was as an able legislator while in the Senate. It was partly through his efforts that yellow fever and bubonic plague were driven out of our country. He will always be gratefully remembered by those afflicted with leprosy, for his outstanding work in establishing a leprosarium which has relieved many States of the Union of the care of persons afflicted with leprosy. It is doing more than this—it is actually curing each year a number of lepers, a fact which is cause for optimism to prevail at the leprosarium. His wide experience in helping to combat disease has fitted him admirably for the new position he now occupies as Executive Director of the Conference Board of the National Institute of Health.

This institution has had an auspicious beginning. Congress has appropriated $750,000, and the Chemical Foundation, through the generosity of its President, Mr. Francis P. Garvan, has donated $100,000. Because of a wise provision in the Act creating the National Institute of Health, the Treasury Department is authorized to accept donations for specific or general purposes, especially for establishing fellowships. When its humane purpose is thoroughly understood by philanthropists, it is anticipated that large donations will be forthcoming to aid in conducting its activities.

Experts in the sciences of medicine, surgery, radiology, chemistry, psychiatry, dentistry, physics, biology, bacteriology, pharmacology, pharmacy, and allied professions will gather at this institution in a concerted drive to prevent disease by ascertaining its cause and applying preventive measures. This work is not to interfere with scientific research of private and state institutions, colleges, hospitals, and laboratories. In fact, all possible help and co-operation will be rendered them by the National Institute of Health.

Radiology has been invited by the Executive Director to participate in the activities of the Institute, and to lend its influence with the other branches of medicine in the fight against disease. This invitation is a

recognition of the importance of radiology, and will be farreaching in its consequences if organized radiology joins hands with organized medicine in endorsing the important work of the National Institute of Health. There can be no doubt of the interest of radiology in this regard, and it should seize with avidity this splendid opportunity to demonstrate that it is indispensable to the onward march of progressive medicine, and its value in research not to be underestimated.

CANCER INSTITUTES

The Cancer Problem is one of the greatest importance on the calendar of medicine today. In spite of the fact that thousands of clinicians and research men in very many different fields of science in all parts of the world have been working upon this subject for many years, the real cause of cancer is still unknown. Not that much progress has not been made, for the knowledge concerning cancer in its many different contacts gained during the last twenty-five or thirty years is very considerable. The research takes the investigator into the whole field of medicine together with many of the sciences which might not be considered as related to medicine in any way.

The diagnosis and treatment of cancer require the co-operation of trained experts of wide experience in many of the specialties of medicine, principally in radiology, surgery, and pathology, together with biochemistry and biophysics. Such a group can exist only in an institution well equipped with research laboratories, hospital facilities, and a large staff of specialists trained in many different branches of science. Research men in physiology, anatomy, physics, biophysics, chemistry, biochemistry, heredity and all the different specialties of medicine perhaps may well co-operate to advantage in consultation with an engineer who has had some training in many of the special sciences. Perhaps some mathematical study of the results of clinical and other research may bring the lines of various theories to the point of intersection, namely, the true theory of the cause of cancer.

A couple of years ago a group of physicians, prominent cancer research men, and a well known engineer met at dinner and had a roundtable discussion on the subject of cancer. The engineer, who was a physicist and chemist, told the group that he thought perhaps an engineer was needed to help solve the cancer problem. He related the story of the sinking of a speedboat, which was observed by spectators from three different shore-lines extending around an angle of about 270 degrees. No difficulty in finding the boat was anticipated, but after a search of several days they were unable to locate it. Finally the engineer stationed the spectators in the respective places in which they had been at the time of the accident and asked them to point out the spot where they saw the boat sink. Each one apparently saw it at a different point. He drew an imaginary line from the point where each individual was standing to the opposite shore, toward which he was looking, through the point where he thought he saw the boat go down. Where all these lines crossed he considered to be the point where the boat should be located, and there it was. The cancer lesson the engineer drew from this was that lines might be drawn through various theories in a similar manner so that a point of intersection, which would represent the true theory, might be found.

To elaborate a little further, recently some of the officers of the Radiological Research Institute, Inc., a newly organized non-profit-sharing corporation whose object is the development of research in radiology, particularly as relates to cancer, visited a large number of research laboratories in

Washington, namely, the Bureau of Standards, Fixed Nitrogen Department of the Bureau of Agriculture, the Carnegie Institute, the laboratories of the Smithsonian Institution, and the National Institute of Health. Afterwards a number of the heads of the Research Departments, together with the Surgeon General, and the Chief of the Bureau of Mines, met with the group at dinner and a roundtable discussion concerning the work of each department represented took place and lasted until the wee sma' hours. These research groups had never been together before to exchange ideas. It was a most interesting and instructive meeting. Everyone seemed to have something to give that interested his neighbor. Some of those present had important contributions which dovetailed with other research in the cancer problem, but they had not known it. They were working in pure science and had little or no thought of cancer. However, the amount of overlapping of experimental work was amazing, but it lacked correlation.

This experience is another evidence that cancer institutions should be organized in every large city in this country, where the subject of cancer can be studied in every branch of science and the results of such clinical and other research can be correlated through clinics and roundtable discussions.

Many millions of dollars annually are spent in agricultural experimental work which assists the farmer in producing food to nourish our bodies, whether we are sick or well. Why not spend equally large amounts in combating a disease which threatens the very existence of the race? Much money is now being spent in public cancer campaigns, which, no doubt, create much public sentiment for the study of cancer and bring the cancer patient earlier for treatment, but, because the expenditure is not properly distributed, these campaigns do not add very materially to our scientific knowledge of the disease. These Cancer Institutes we believe should be organized and controlled by private philanthropy, rather than by the State or municipality, in which latter cases politics are too likely to control the institute activities.

Dr. Francis Carter Wood estimated that the cost of building, equipping, and endowing such an institute would be not less than ten million dollars. We note that Dr. James Ewing, in a recent communication, makes a like estimate. The philanthropist who establishes such an institute on a sound basis in a large, popular center will do more for humanity with his money than he could do in any other way. Such an institute should be an educational center, connected with a university or teaching institution, as Dr. Ewing points out, for the layman and the student, the undergraduate, and the postgraduate. If true information were given to the public through such an institution, some of the millions that are now spent worse than uselessly on quacks who prey on the ignorance of the laymen in regard to cancer might well be conserved for honest scientific search for the truth in properly equipped institutes distributed throughout the country.

There are now several institutes for cancer in the world which are adding greatly to our knowledge every year. These are, notably, in Paris, Stockholm, London, Heidelberg, Rome, Havana, Montreal, New York, Buffalo, Baltimore, and St. Louis. None of them has sufficient endowment.

Thousands of medical and research men the world over are devoting their lives unselfishly to the study of cancer, without hope of reward other than that which comes with the satisfaction of having made a contribution to the relief of suffering humanity. The American College of Surgeons, aided by the American Society for the Control of Cancer, is carrying out a very elaborate program for scientific study of cancer and education of the physician and the layman. The share

which doctors are freely giving cannot be estimated in dollars.

Where are the unselfish, big-hearted, socially minded millionaires who will do their share? Who will be the first great American to establish and properly endow the next great Institute for Cancer in this country? And then, who will follow suit, so that every large center will have an institute? What a wonderful opportunity this is for the man with large means to confer a blessing on humanity, by providing the sinews for the conquest of one of the most prevalent and most torturing of the diseases which afflict mankind and one which actually threatens extinction of the race—a thoroughly equipped and endowed cancer institute!

ROLLIN H. STEVENS, M.D.

ANNOUNCEMENTS

THE EIGHTH ANNUAL MEETING OF THE AMERICAN COLLEGE OF RADIOLOGY

PHILADELPHIA, JUNE 9 AND 10, 1931

The Eighth Annual Meeting of the Chancellors of the American College of Radiology was held at the Penn Athletic Club, Philadelphia, on the evening of June 9, 1931, President-elect Arthur C. Christie, M.D., in the chair.

The following officers were elected for the ensuing year:

ALBERT SOILAND, M.D., of Los Angeles, President-elect;

WILLIAM A. EVANS, M.D., of Detroit, Vice-president;

B. H. ORNDOFF, M.D., of Chicago, Executive Secretary;

HENRY SCHMITZ, M.D., of Chicago, Treasurer;

I. S. TROSTLER, M.D., of Chicago, Historian.

Dr. Soiland organized the College eight years ago, the first meeting being held in San Francisco with a charter membership of 70.

The Chancellors agreed to confer a gold medal upon Prof. Charles C. Lauritsen, of Pasadena, California, and Mme. Marie Curie, of Paris, for valuable contributions to radiology, and honorary fellowships upon Prof. Ledoux-Lebard, of Paris, and Dr. Joseph C. Bloodgood, of Baltimore, Maryland.

The Annual Convocation was held at the same location on the next evening. At this meeting the second gold medal of the College was bestowed upon Prof. Charles C. Lauritsen, of the California Institute of Technology, in recognition of his work in developing the first super-high voltage X-ray tube. An honorary fellowship was conferred upon Dr. Joseph Colt Bloodgood, of Johns Hopkins Hospital and University, Baltimore, for his interesting contributions to the progress of radiology.

The Fellowship degree was conferred upon the following candidates:

RALPH BROMER, M.D., of Philadelphia;

CLYDE K. HASLEY, M.D., of Detroit;

LAWRENCE REYNOLDS, M.D., of Detroit;

LESTER J. WILLIAMS, M.D., of Baton Rouge;

WILLIAM L. CLARK, M.D., of Philadelphia.

Dr. George E. Pfahler presented a beautiful gavel made from prehistoric ivory found in the glaciers of Alaska, which, in turn, is to be presented by the College and the other American radiological societies to the Third International Congress on Radiology in Paris.

Dr. B. H. Orndoff told about preparations for an American Congress on Radiology to be held in Chicago during the World's Fair in 1933. If all American radiological societies will merge their annual sessions in this Congress, the latter will mark an important epoch of progress in ra-

diology and be the means of conserving and utilizing to the best advantage the forces of American radiologists.

Dr. Joseph Colt Bloodgood gave a brief but splendid talk on the great progress and value of radiology in medicine, especially in the diagnosis and treatment of cancer.

Dr. C. C. Lauritsen spoke entertainingly of the development of his super-voltage apparatus. It was curiosity concerning the energy locked up in the nucleus of the atom that led him to develop high voltage X-radiations in order to study their different spectra. There are only 92 elements and they differ one from another only in the number of electrons which are more or less tightly bound about the central nucleus of the atom: 177,000 volts are sufficient to dislodge the most tightly adherent electron of any element. Therefore, the question arose as to what happened to cause characteristic spectral lines with 200,000 volts of our deep therapy apparatus and 2.6 million volts as found in radium. His apparatus consists of a high tension alternate current transformer without rectification and a tube of glass sections, 1 foot in diameter and 12 feet long, which are put together with rubber and cement. The glass is lined with steel casing 6 mm. thick to prevent puncture of the glass.

A few patients have been treated during the past few months by this tube at 550 K.V., under the direction of Dr. Soiland. Dr. Packard, associated with Dr. Francis Carter Wood, has been studying dosage of the tube on fruit-fly eggs.

A third tube is now under construction in a new building being built through the generosity of Mr. Kellogg, which will be devoted to therapy alone.

The Retiring President, Rollin H. Stevens, M.D., read an address in which he strongly advocated that the College take steps to recognize radiology as a specialty only through certain educational qualifications and examinations, to standardize radiological requirements in hospitals, and to elevate the standards of radiological education in colleges. The suggestions were referred to the Board of Chancellors for their consideration. The address in full follows.

THE RÔLE OF THE AMERICAN COLLEGE OF RADIOLOGY IN MEDICINE

The American College of Radiology was organized in June, 1923, just eight years ago, with the following objects as stated in the constitution, namely:

1. "To create a fellowship among medical men who have distinguished themselves in the science of radiology;

2. "To arrange for a Congress of Radiology to be known as the American Congress of Radiology, which shall consist of such scientific sessions, exhibits, demonstrations, and clinics as may be provided for and directed by the American College of Radiology through its Board of Chancellors at such times and places as they may deem advisable."

This College has met regularly every year and conferred the degree of F.A.C.R. upon some 110 candidates, and honorary fellowships upon 32. It has faithfully observed the spirit of the object as expressed in Section 1, and is now planning to carry into effect the object, as expressed in Section 2, by beginning preparations for the first American Congress in Radiology to be held in Chicago during the World's Fair in 1933.

Is this all with which this organization should concern itself? By no means. It must ever progress and give greater service to the cause of medicine and the needs of the public if it would live and be worthy of the name it bears.

Education.—The proper scientific and ethical education of those who follow us should be the greatest concern of the American College of Radiology. We, who have

had many years of experience; we, who have been pioneers; we, who have been obliged to teach ourselves, to learn from our mutual experiences as we have met in each other's laboratories, or at our organized meetings, must now see to it that the coming generations of radiologists are not merely technicians, but are well grounded in the medical as well as the allied radiological sciences that are their inheritance in order that they may serve humanity better. They must not only be expert in fluoroscopy and in the interpretation of roentgenograms, but must be expert consultants in any branch of medicine. They must advise concerning the nature of the disease they are diagnosing from a roentgen point of view, and discuss or suggest the most advantageous treatment. They must be expert radiotherapeutists and sense the proper limitations as well as advantages of such therapy.

A committee from this organization should study the facilities of colleges and hospitals for giving proper instruction in roentgen anatomy, physiology, pathology, and radiation biochemistry. Such instruction should be more or less standardized, always subject to change, of course, as progress is made. Other organizations are attempting to do this for us now, and perhaps we should not complain that they are undertaking the job, because we have been negligent and derelict in our duty. But no organization outside of radiology, surely, can be so competent to create the required standards as can an organization of veteran radiologists. Where such standardization is now in process of accomplishment this organization might well, in a kindly way, offer its assistance. Let us co-operate for satisfactory service. But, in order to maintain our calling as a high class specialty, we should put ourselves to the test and claim special or expert knowledge only when we have been examined and found competent. Let us do it ourselves soon before someone else does it. The ophthalmologists have long since set the noble example.

The Education of the Medical Profession as to the Importance of Expert Service in Radiology.—Commercial X-ray laboratories operated by technicians and nominally supervised by medical men (who are often known to be wholly incompetent); profit-sharing stock company (or, more properly, fee-splitting) laboratories owned by groups of medical men, and operated by so-called roentgenologists, who are hired at small salaries; radium rental agencies, all have sprung up in various parts of the country. Doctors in good standing patronize them freely, else they could not exist. They do so perhaps because they are cheaper than recognized roentgenologists, or because they divide their fees with the referring physicians, or because the latter do not appreciate the value of the services of well-trained, well-informed, experienced radiologists. Referring physicians do not always realize that large experience, exchange of knowledge presented at radiological society meetings, together with long and special study of the physics, chemistry, and biology of the X-ray and radium, make the expert who can be of real assistance to them and their patients, and that too often false and dangerous information may emanate from the commercialized laboratory. Perhaps they do not realize that they are violating the ethics of their profession. The doctor who has not had special training in radiology, who rents radium to administer according to set and printed directions given by a lessor who does not even see the patient, is performing a dangerous act which is likely to result seriously for his patient. The treatment may do irreparable injury—directly, by improper over-dosage, or indirectly, by improper, insufficient dosage. The latter may deprive the patient of the chance of cure that the expert might have given him. There

is nothing in medicine more difficult or requiring more expert knowledge and experience in so many different branches of science than radiotherapy. This knowledge and the ethics of service to humanity must be driven home to the profession in some way. Is it a function of this College to take some action in this matter? I believe it is.

Radiological Standardization in Hospitals.—The professional and mechanical radiological equipment of hospitals has gone forward at a rapid pace with little or no supervision, and the result presents a rather complicated problem to solve at this date. Considerable diplomatic education, ethical and otherwise, is needed badly by many hospital managements on this subjects.

Hospitals have pretty generally been niggardly in assigning space for X-ray equipment, yet there is no other department that is more depended upon for the diagnosis and treatment of disease. There is no other department where the proper amount of space means so much for the safety of both patient and operator. Hospitals look with covetous eyes upon the earnings of the X-ray department. Why, we do not know, as the cost of maintenance and equipment of X-ray departments generally absorbs most of the earnings. Frequent changes of, and additions to, expensive apparatus are almost obligatory in order to give the best service. There is a tendency on the part of hospital managements to substitute inexperienced radiologists for experts, and thus cut down on the item of salary expense, or to appropriate to the use of the institution the earnings of the expert radiologist who has built up the reputation of his department.

Of course, operating a hospital is no sinecure. It is difficult to make both ends meet and provide modern luxurious service at reasonable cost to the patient. So the temptation to take from the doctor is strong.

The College of Surgeons is endeavoring to standardize radiology in hospitals—a very desirable thing to do, but would they not succeed better with the help of the experienced men of the College of Radiology? Is this not an important function of this College? Should we not have a carefully selected committee on standardization of radiology in hospitals?

Standardization of the Diagnosis and Treatment of Cancer in Clinics and Hospitals.—Dr. Karl L. Sicherman, a prominent surgeon, writing in the *Michigan State Medical Journal* on "Famous Men in Medical History," says, "Surgery has never been a modest science, hiding its light under the bushel of reticence, or underrating its achievements." How true!

The American College of Surgeons is attempting to effect the very worthy plan of standardizing the diagnosis and treatment of cancer in clinics and hospitals. It modestly (?) takes the following stand, as quoted by Dr. Burton J. Lee: "The American College of Surgeons takes the stand that cancer is, in principle, a surgical problem; that the diagnosis and treatment of cancer should be recognized as a responsibility of the surgeon or radiologist who has had surgical training; that he should be qualified for his work by experience in the surgical pathology of tumors and in the employment of radiation methods as well as surgery for both the radical and palliative treatment of cancer, and that he should work in close co-operation and consultation with the radiologist in the use of X-ray treatment."

It would seem that the dogmatic statement that "cancer is, in principle, a surgical problem," is almost if not quite out of date, and unworthy a scientific doctor. We all know that in these days at least quite as much is done for cancer by the expert radiologist as by the surgeon. We also believe that the expert radiologist treating cancer is quite as capable of making a diagnosis as is the surgeon, because of the fact

that his experience with cancer is certainly as large if not much larger than that of the surgeon. Why the modest (?) surgeon should still, in 1930, assign to the radiologist a position of lesser responsibility in the matter of cancer, we do not know. However, eight years ago, when the College of Radiology was organized, the radiologist did not get nearly as much recognition as he does now. He is coming up in the world.

Seriously, neither surgeon nor radiologist has any right to claim the cancer problem as strictly his own, because neither surgery nor radiation has yet been proven a cancer cure—far from it. In the final conclusion, neither the surgeon nor the radiologist may be in the picture. We have much to learn yet from the biochemist and biophysicist as well as from the pathologist. The radiologist, especially if he is engaged in pure research, is making many valuable contributions to our knowledge of cancer. The American College of Radiology should have a committee on cancer research and should be interested in the standardization of cancer diagnosis and treatment in hospitals. This committee should co-operate with the Radiological Research Institute, Inc., which is a non-profit-sharing corporation interested in all radiological research, and particularly as it relates to cancer. This Institute is now supporting five fellowships in various institutions of learning and research. It has also taken an active part in endeavoring to prevent further monopoly of the manufacture of X-ray tubes.

In order to gain power to carry into effect some of the plans we have mentioned, we are of the opinion that the College of Radiology should largely increase its membership. As we have said, it has been in existence eight years. In that time many radiologists have passed their ten-year period of specializing in radiology. Our high standard of membership requirements could be made still higher and still admit a large number of radiologists who would add vigor, power, and luster to our organization. The larger number would have more influence in bringing together the several separate radiological societies now operating at a greatly increased cost in time and money to most of us, a cost which we can ill afford. One Congress meeting annually under the auspices of the College would seem to meet our requirements, or one of the other societies might choose to exist as a separate limited organization, yet the great work and greatest influence would be in the Congress sponsored by the College.

I would suggest amending our constitution by adding to Article 2 a third section, namely:

"Section 3. To establish and modify from time to time, as progress demands, a minimum standard of education for specialists in radiology."

THE ST. LOUIS MEETING

LOCAL COMMITTEES

Those whose names are enumerated below have been chosen to make preparations for and further the interests of the Seventeenth Annual Meeting of the Society, to be held in St. Louis, at the New Hotel Jefferson, Nov. 30–Dec. 4, 1931.

Local Executive Committee

EDWIN C. ERNST, M.D., *Chairman*, St. Louis, Mo.
GRAY C. BRIGGS, M.D., St. Louis, Mo.
L. G. MCCUTCHEON, M.D., St. Louis, Mo.
SHERWOOD MOORE, M.D., St. Louis, Mo.
JOSEPH C. PEDEN, M.D., St. Louis, Mo.
L. R. SANTE, M.D., St. Louis, Mo.
P. C. SCHNOEBELEN, M.D., St. Louis, Mo.
E. W. SPINZIG, M.D., St. Louis, Mo.
PAUL F. TITTERINGTON, M.D., St. Louis, Mo.

OSCAR C. ZINK, M.D., St. Louis, Mo.
C. E. HYNDMAN, M.D., St. Louis, Mo. (by invitation).

Hotels Committee

OSCAR C. ZINK, M.D., *Chairman,* St. Louis, Mo.
CARL A. W. ZIMMERMANN, M.D., Cape Girardeau, Mo.

Scientific Sessions Committee

L. R. SANTE, M.D., *Chairman,* St. Louis, Mo.
W. K. MUELLER, M.D., St. Louis, Mo.
L. R. WEBB, M.D., Springfield, Mo.

Scientific Exhibits Committee

PAUL F. TITTERINGTON, M.D., *Chairman,* St. Louis, Mo.
C. E. GILLILAND, M.D., St. Louis, Mo.
O. O. GIBERSON, M.D., Alton, Ill.

Commercial Exhibits Committee

I. S. TROSTLER, M.D., *Chairman,* Chicago, Ill.
PAUL F. TITTERINGTON, M.D., St. Louis, Mo.

Clinics Committee

SHERWOOD MOORE, M.D., *Chairman,* St. Louis, Mo.
PAUL F. COLE, M.D., Springfield, Mo.
A. H. DIEHR, M.D., St. Louis, Mo.

Entertainment Committee

JOSEPH C. PEDEN, M.D., *Chairman,* St. Louis, Mo.
CARL DICK, M.D., St. Louis, Mo.
J. W. LARIMORE, M.D., St. Louis, Mo.
DR. HERBERT E. MUENCH, St. Louis, Mo. (by invitation).
FRED S. O'HARA, M.D., Springfield, Ill.
RALPH THOMPSON, M.D., St. Louis, Mo. (by invitation).

Transportation Committee

P. C. SCHNOEBELEN, M.D., St. Louis, Mo. (by invitation).
FRED B. HALL, M.D., St. Louis, Mo. (by invitation).

Banquet Night Committee

E. W. SPINZIG, M.D., *Chairman,* St. Louis, Mo.
J. C. LYTER, M.D., St. Louis, Mo.
J. S. YOUNG, M.D., East St. Louis, Ill.
CHARLES A. VOSBURGH, M.D., St. Louis, Mo.

Publicity Committee

E. H. KESSLER, M.D., *Chairman,* St. Louis, Mo.
MR. ELMER H. BARTELSMEYER, Executive Secretary St. Louis Medical Society, St. Louis, Mo. (by invitation).
ELLIS FISCHEL, M.D., State Chairman of the American Society for the Control of Cancer, St. Louis, Mo. (by invitation).
F. J. V. KREBS, M.D., Chairman of the Health and Public Instruction Committee, of the St. Louis Medical Society, St. Louis, Mo. (by invitation).
LAWRENCE D. THOMPSON, M.D., Editor of the *Weekly Bulletin of the St. Louis Medical Society,* St. Louis, Mo. (by invitation).

Local Finance Committee

L. G. MCCUTCHEN, M.D., *Chairman,* St. Louis, Mo.
MR. A. W. BUCK, St. Louis, Mo. (by invitation).
MR. A. K. HAINES, St. Louis, Mo. (by invitation).
MR. J. P. JUDGE, St. Louis, Mo. (by invitation).
MR. F. C. SCHNOEBERGER, St. Louis, Mo. (by invitation).

Ladies' Entertainment Committee

MRS. GRAY C. BRIGGS
MRS. EDWIN C. ERNST
MRS. EDWARD H. KESSLER
MRS. L. G. MCCUTCHEN
MRS. SHERWOOD MOORE

MRS. JOSEPH C. PEDEN
MRS. L. R. SANTE
MRS. PAUL C. SCHNOEBELEN
MRS. EDGAR W. SPINZIG
MRS. PAUL F. TITTERINGTON
MRS. OSCAR C. ZINK
MRS. FRANCIS PEDER
MRS. C. E. HYNDMAN

RADIOLOGICAL SECTION OF THE CANADIAN MEDICAL ASSOCIATION

The Radiological Section of the Canadian Medical Association met in Vancouver, B. C., on June 24 and 25, to listen to the following program:

OMAR G. HAGUE, M.D., of Winnipeg, Man.: "Silicosis."

DOUGLAS QUICK, M.D., of New York: "Intra-oral Cancer."

W. H. MCGUFFIN, M.D., of Calgary, Alberta: "A Radiological Study of Osteomyelitis."

B. R. MOONEY, M.D., of Edmonton, Alberta: "The Lumbar Spine."

W. L. RITCHIE, M.D., and F. S. PATCH, M.D., of Montreal: Symposium on "Clinical and Radiological Aspects of Pyelography; Intravenous and Retrograde."

J. B. HARRISON, M.D., of Vancouver, B. C.: "Some Questions Regarding Stereoscopy in Radiology."

C. M. HENRY, M.D., of Regina, Sask.: "Roentgenologists: Their Relation to Hospitals and the Medical Profession."

EARLE E. SHEPLEY, M.D., of Saskatoon, Sask.: "The Responsibility of the Radiologist in Relation to Malignancy."

Bernard R. Mooney, M.D., of Edmonton, Alberta, was Chairman, and C. W. Prowd, M.D., of Vancouver, B. C., was Secretary.

THE ROENTGEN MONUMENT IN LENNEP

By OTTO GLASSER, PH.D.
Cleveland Clinic, CLEVELAND, OHIO

On November 2, 1929, the Rheinisch-Westfaelische Roentgen Society, through its founder and president, Prof. Paul Krause, in Münster, proposed that a life-size monument of Wilhelm Conrad Roentgen be erected in Lennep, his birthplace.

The Roentgen Monument, Lennep, Germany.

On November 28, 1929, Prof. Krause wrote a letter to the roentgenologists of America giving them an opportunity to contribute to a fund to be used in erecting this monument. On March 15, 1930, we sent out 1,380 letters to American roentgenologists and also published a short note in the radiological journals, asking for contributions. The response was gratifying: 140 radiologists sent contributions totaling $1,029.90.

After deducting a small amount for expenditures, a total of 4,050 marks was sent to Prof. Krause on May 1 and September 9, 1930, together with the names of the contributors. This amount covered about one-fifth of the total cost of the monument.

The contributors were invited by Prof. Krause to attend the dedication exercises, which took place on November 29 and 30, in Lennep. However, the invitation, which was also sent to the radiological journals, arrived too late for the contributors to avail themselves of it.

The dedication exercises began on November 29 with a scientific meeting of the Rheinisch-Westfaelische Roentgen Society, at which prominent German roentgenologists delivered addresses. On Sunday, November 30, 1930, the monument was unveiled by Prof. Krause.

The Roentgen monument itself was designed and executed by the German artist, Arno Breker. It symbolizes the genius of light; a woman walks forward with closed eyes, holding in her right hand a lighted torch which she protects from the wind with her left hand. She advances serenely against a strong wind which threatens to stop her progress. The monument, which is constructed of bronze, stands on a large square stone, the front of which bears a profile in relief of Roentgen.

The proceedings of the dedication exercises have been collected by Prof. Krause in a "Röntgen-Gedächtnis-Heft" which was published recently. We received five copies from Prof. Krause, two of which were forwarded to the Editors of the *American Journal of Roentgenology and Radium Therapy* and of RADIOLOGY. The remaining copies are at the disposal of the contributors to the fund. Prof. Krause has also forwarded one hundred photographs of the house in Lennep in which Wilhelm Conrad Roentgen was born on March 27, 1845. Any contributor who is interested in having one of these pictures may secure it by writing to us.

CHOLECYSTOGRAPHY AND IODEIKON

Since the first report by Graham and Cole upon cholecystography, many articles on the subject have appeared in medical literature. Extensive research has resulted in perfection of technic, which makes this method of diagnosis of gall-bladder conditions increasingly reliable. A booklet has just been published by the C. V. Mosby Company, of St. Louis, called "The Biography of Iodeikon," which contains a review of the literature on cholecystography and also supplies complete details for both oral and intravenous administration of Iodeikon (tetraiodophenolphthalein), the dye employed for cholecystography in connection with the work of Graham and Cole.

A complimentary copy of this new booklet may be obtained by writing Mallinckrodt Chemical Works, Second and Mallinckrodt Streets, St. Louis, Mo.

BOOK REVIEWS

RECENT ADVANCES IN RADIOLOGY. By PETER KERLEY, M.B., B.Ch. (N.U.I.), D.M.R.E. (Camb.), Assistant Radiologist, Westminster Hospital; Radiologist, The Royal Hospital for Diseases of the Chest. Published by P. Blakiston's Son and Co., Inc., Philadelphia, 1931. Pages 324, with 120 illustrations. Price $3.50.

As stated by the author, this book is written primarily for the general practitioner who may be interested in radiology. Most of the advances in radiographic diagnosis and to a much lesser extent those in radiotherapy, are considered. It is obvious-

ly impossible to deal at length with all the advances in a book of this size; hence, those concerned with technic and physics, which convey little to the general medical man, are largely omitted. Those sections pertaining to the skull, heart, lungs, and gastro-intestinal tract are exceedingly well presented. It is to be regretted, however, that such subjects as foreign bodies in the respiratory tract, and encephalography have been overlooked. In spite of these shortcomings, the author has covered a large field in a very satisfactory manner, and, true to its purpose, this book will interest the general practitioner and less experienced radiologist.

THEORIE ET PRATIQUE DE LA TELECURIE-THERAPIE. By MAX CHEVAL and A. P. DUSTIN. Pages, 236; figures, 76. Published by Masson et Cie, 120 Boulevard Saint Germain, Paris, France, 1931. Price, 34 francs.

This book presents the authors' experience at the University of Brussels with telecurietherapy (radium therapy at a distance) by means of an "element pack" or "radium cannon," in the treatment of various forms of malignant disease. Throughout the whole work the cytologic and anatomicopathologic changes are emphasized, for it is largely by them that indications of the clinical and biologic effects of radiation are obtained. Even though the time during which this method has been in use is too short to allow any definite conclusions to be drawn, it is long enough to permit a discussion of the technic, to solve some of its difficulties, and to bring to light some of its advantages and drawbacks.

In the first chapter (pages 5 to 47) the authors survey briefly the similar work carried out by Regaud, Mme. Laborde, Lysholm, Quick, Capelli, and the Westminster Hospital in London.

The authors illustrate, by drawings and photographs, the construction of their apparatus, which differs from those of other clinics. It contains 20 (200 milligram) tubes of radium element in monel metal, enclosed in a block of lead of special construction, 45 by 34 by 14 cm., and covered by appropriate secondary filters of iron, aluminum, and wood. The whole apparatus weighs about 300 kilograms. The ports of entry are so arranged that by means of special treatment tables the radium container can be adjusted by a hoist. Two patients may be irradiated simultaneously, and accurately placed in contact with the port of entry at the correct distance and angle.

The filtration of the device, 1 millimeter of platinum, was checked photographically and by an iontoquantimeter and found to produce a pure gamma radiation in a field 22 cm. square (or an area of 484 sq. cm.) 10 cm. beneath the surface.

As a basis of dosage the authors have selected the D unit, which is the quantity of radiation received in one hour by a point situated 2 cm. from a point containing 100 milligrams of radium element in a filter of 2 mm. of platinum. The apparatus gave 0.99 D in one hour at a distance of 12 cm., and since each exposure was set at 50 minutes, the skin received a dose of 0.82 D. Most treatments were carried out at a distance of 16 centimeters. The authors used 18 to 24 D in the depths as a rule. Depth doses were increased by cross-fire. By treating two patients simultaneously it was possible to treat about one hundred patients each year.

In the second chapter (pages 48 to 195), there is presented a detailed analysis and discussion, illustrated by many charts and drawings, of the effects of this type of radiation on normal and pathologic tissues, the latter being studied by frequent biopsy after treatment. The reactions of all malignant tumors to this radiation are fundamentally

the same, and can be divided into three characteristic phases: Decrease in number of normal mitoses, appearance of waves of atypical mitoses, cessation of mitoses, or amitotic stage. Finally this phase of amitosis, if not accompanied by complete degeneration, is followed after a variable period of latency by return of hyperkinetic activity, then by normal rhythm. Tumors vary among themselves in the rapidity, the extent, and the duration of these oscillations. They differ from normal tissues in having usually a greater sensitivity and more marked reactions. A bibliography (pages 194 to 197) closes this chapter.

In the clinical chapter (pages 199 to 234), there are illustrated the technical aspects of the treatment of various lesions, together with case histories and after-results. Even though the great majority of patients treated were in an advanced, unfavorable stage, sufficient benefit was obtained in most instances to make treatment worth while. Forty-seven intra-oral cancers were treated: two of three favorable cases of cancer of the tongue were cured; four of seven tonsillar cancer; neither of two laryngeal, and one of two lip cases, all for four years. Eight patients with cancer of the esophagus were treated, of whom one survived for two years, and one for eight months in the two favorable cases treated. Thirty-six cases of cancer of the cervix included 20 cases not operated upon and 16 post-operative recurrences. In the operable group there was obtained one cure in two favorable cases; in the borderline, five in eight favorable cases; in the inoperable, one in three favorable cases; in the recurrent, five in twelve. The authors are of the opinion that cervical cancer is best treated with a combination of telecuriethertherapy and local radium therapy. In the breast group, 25 cases were treated. Telecuriethertherapy gave two cures in the two favorable cases treated; telecuriethertherapy followed by radical operation gave one cure in two favorable cases; in post-operative recurrences, two cures in four favorable cases. Of the 13 patients with rectal cancer who were treated, one is still living. Twenty cases of sarcoma of various kinds were treated. The authors draw no conclusions, as their group is insufficient, but they state that some are highly radiosensitive.

Telecuriethertherapy is a method of palliating cases in which other forms of treatment offer very little. It may be used as an accessory to other forms of treatment and in certain groups may, by itself, act as a curative measure. The drawbacks to it are that it is expensive and is limited to a few cases per year.

This book is practical, covers the subject thoroughly, and is very interesting to read. The subject matter is of value not only to those who may have the facilities of 4 grams of radium, but also to anyone who is at all intrigued by the present tendency toward the gamma-ray therapy of cancer.

NERVOUS INDIGESTION. By WALTER C. ALVAREZ, M.D., Associate Professor of Medicine, University of Minnesota (The Mayo Foundation). Pages, 297. Published by Paul B. Hoeber, Inc., New York City, 1930. Price, $3.75.

The author has used the term "nervous indigestion" to designate all those gastro-intestinal disturbances for which no organic cause can be found. This oft-neglected phase of gastro-intestinal disorders is considered by him in a very practical and most interesting manner. In addition to the medical side, he has presented a phase of medicine often overlooked—the patient's viewpoint. The contents attest the author's large experience and his comments and advice embrace much of the so-called "art of medicine."

The following extracts will cause some roentgenologists to raise their eyebrows—nevertheless, they contain much food for thought:

"Many roentgenologists endear themselves to their surgical friends by making the diagnosis of appendicitis for them. Many are the men or women who have consented to a needless operation simply because the attending physician or surgeon was able to point menacingly to the shadow of an appendix that was a little long or a little short, a little bent, or perhaps a little slow in emptying. I have never been able to convince myself that appendicitis can be diagnosed in this way, and I know a number of experienced roentgenologists who feel as I do. I realize that so long as human nature is what it is, the roentgenologist who depends on referred work will have to have rare courage and idealism and a strong feeling of responsibility to his fellow-men before he can do as he should do and write 'normal digestive tract' on most of the reports which he sends out. He knows that the physicians who send him work want positive diagnoses made for them, and the temptation is great to expatiate on slight congenital abnormalities, slight stasis here and there, normal kinks, ptoses, and suggestions of adhesions, appendicitis, and colitis, As I have already intimated, the tragedy is that such a report in the hands of an inexperienced, overly optimistic, lazy, or unscrupulous physician can be used as a powerful instrument for driving the patient into a useless operation."

. . . . . .

"Years ago, I would have classified a number of the thin, congenitally handicapped patients as victims of enteroptosis, but now that I know how commonly this condition is found in healthy persons, I doubt the wisdom of ascribing symptoms to it. Some persons doubtless feel better while wearing a good corset or an abdominal support, but this does not convince me that enteroptosis is a disease. I think I would as willingly ascribe symptoms to a large navel, to a hooked nose, or to flaring ears, as to a mobile cecum or to a redundant sigmoid flexure. The bowel is a muscular tube and I doubt very much if its position in the abdomen has much influence on the rate at which its contents are passed onward. Certain it is that innumerable persons with the most pronounced ptosis imaginable are perfectly healthy."

. . . . . .

"Mucous colitis is another condition which accounts for much unnecessary opening of the abdomen. It seems to me obvious that the disease is not a true colitis. In most cases there appear to exist, first, a congenital predisposition; second, a hypersensitiveness to many types of stimuli, and third, perhaps some local source of irritation in the pelvis. That the disease is often purely nervous in origin can be seen from the fact that occasionally a man or woman who has never had trouble before will, after heavy nervous strain, suffer a violent attack and will pass a large mucous cast of the bowel. That there are other, possibly metabolic, causes is indicated by the fact that the disease sometimes makes its appearance in middle-aged men who have not been particularly nervous. I think it is unfair to frighten patients by telling them that they have colitis simply because they are constipated or because roentgenographs of the colon show a tendency to spasm. The ending, 'itis,' as used to-day in medicine, means 'inflammation.' The term 'colitis,' therefore, should mean 'inflammation of the colon' and it should, I think, be reserved to describe those cases in which ulceration or inflammation can be demonstrated."

The concluding chapter contains some practical points about the physiology and innervation of the digestive tract, which will interest those who are not already familiar

with the author's work on the mechanics of the digestive tract.

All physicians and many patients will find much of value in this book.

LIBRARY OF RADIOGRAPHIC FILMS. BY HENRI BÉCLÈRE and PIERRE PORCHER. Published by Masson et Cie, 120 Boulevard Saint Germain, Paris (VI). Price 25 francs per series.

There are few radiologists who, at one time or another, have not wished that they possessed a collection of lantern slides or films illustrating the normal and abnormal conditions common to radiology. Except for those affiliated with large institutions, the realization of this wish has not generally been possible. It has remained for Béclère and Porcher to make available to radiologists a library of radiographic films that will interest all who have long desired to possess such a collection.

Instead of reducing the original films on lantern slides, the originators of this library have conceived the very practical idea of reducing them on standard size (35 mm.) moving picture film. The reductions in the positive are placed horizontally, side by side on a strip of film 8¾ inches long. The edges of the film strip are bound with thin metal to prevent buckling and to facilitate handling. The strips are above the size of the magic lantern slides of our childhood days, and are readily projected in an ordinary stereopticon by means of a special, inexpensive carrier that may be purchased from the manufacturers or easily built. By making a slight modification in the gate aperture, the strips may be projected by the ordinary film slide projectors. Those who prefer to use lantern slides instead of the film strips can easily make contact slides direct from the films.

At the present time the Library contains a series of films on fifty subjects. Each series comprises thirty pictures, consecutively numbered and mounted on three strips of ten each. The sample series sent for examination are excellent reproductions of fine radiographs and gross-specimen photographs. When projected in a lantern slide projector, the detail was excellent and quite comparable to that obtained with lantern slides.

The originators of this idea are to be commended for making available to radiologists in an unique, practical, and inexpensive manner, such a fine collection of radiographs.

ABSTRACTS OF CURRENT LITERATURE

CONTENTS BY SUBJECT

Abdomen 599
Apparatus 599
Arthritis 599
Bactericidal Effect 600
Blood Changes 600
Bone (Diagnosis) 600
Bone (Therapy) 601
Bone Diseases (Diagnosis) 601
Bone Diseases (Therapy) 602
The Brain 603
Cancer (Diagnosis) 603
Cancer (Therapy) 605
Chemical 606
The Chest (Diagnosis) 617
The Chest (General) 617
The Chest (Therapy) 619
Contrast Media 620
Dental Radiography 622
Diaphragmatic Hernia 622
Diathermy 622
The Ear 623
The Esophagus (Diagnosis) 624
Experimental Studies 625
Foreign Bodies 626
Gall Bladder (Normal and Pathologic) 626
Gastro-intestinal Tract (Diagnosis) 626
Genito-urinary Tract (Diagnosis) 631
Genito-urinary Tract (Therapy) 633
Grenz Rays 633
Gynecology and Obstetrics 634
Heart and Vascular System (Diagnosis) 635
Heart and Vascular System (Therapy) 635
The Kidney 636
The Liver 636
Measurement of Radiation 637
Myositis Ossificans 640
Physical Therapy 641
Radiation Sickness 642
Radium 642
Respiratory Tract 644
Rickets (Therapy) 644
Roentgenotherapy 644
Roentgen Injuries 645
The Sinuses (Diagnosis) 645
The Skin (Therapy) 646
The Skull (Diagnosis) 646
The Spine (Diagnosis) 647
The Thymus (Diagnosis) 648
The Tonsils 649
Tuberculosis (Diagnosis) 649
Tuberculosis (Therapy) 653
Tumors (Diagnosis) 654
Ulcer (Etiology) 655
Ulcer (Perforating) 655
Ultra-violet Light 655

THE FOLLOWING ABSTRACTORS HAVE CONTRIBUTED TO THIS ISSUE

J. N. Ané, M.D.
Charles S. Capp, M.D.
L. J. Carter, M.D.
F. Cavers, D.Sc., M.R.C.S.
Donald S. Childs, M.D.
Charles H. DeWitt, M.D.
M. J. Geyman, M.D.
J. E. Habbe, M.D.
Alan L. Hart, M.D.
H. W. Hefke, M.D.
Paul C. Hodges, M.D.
H. A. Jarre, M.D.
E. T. Leddy, M.D.
W. D. Mackenzie, M.D.
F. B. Mandeville, M.D.
L. Marinelli
J. M. Mora, M.D.
H. C. Ochsner, M.D.
Davis H. Pardoll, M.D.
Willis S. Peck, M.D.
Ernst A. Pohle, M.D., Ph.D.
Charles G. Sutherland, M.D.
Jacob H. Vastine, M.D.
E. C. Vogt, M.D.
W. W. Watkins, M.D.

ABDOMEN

The Autoplastic Function of the Gastric Mucosa. W. Brednow. Fortschr. a. d. Geb. d. Röntgenstr., January, 1931, XLIII, 91.

To clarify the differences in opinion concerning autoplastic function of the gastric mucosa, as announced by Forssell, Chaoul, and others, the author investigated the gastric mucosa in a somewhat modified form. Besides administering enough barium suspension to outline the mucosal gastric folds, he requested the patient to partake of a plum-sized, poorly digestible capsule filled with barium sulphate. Roentgenograms were made repeatedly, following such procedure at short intervals. They clearly show the ability of the gastric mucosa to adapt itself to particular needs, extensively transform its configuration, and thus entirely confirm Forssell's contention that a very pronounced adaptability of the gastric mucosa may alter the rugal relief very widely as an expression of its intrinsic function.

It is quite evident from this paper that one must pay due attention to prevailing circumstances if mistakes in diagnosis from studies on the gastric mucosa are to be avoided.

H. A. Jarre, M.D.

APPARATUS

A Spinthariscope for Measuring Radio-activity. H. A. Mangan and Herman Schlundt. Trans. Electrochem. Soc., 1931, LIX.

The spinthariscope is serviceable in rapidly establishing the fact of radio-activity in living persons, but in its present form it is quite inferior to the electroscope for accurate estimation of small quantities of radio-active emanations.

Chemical Abstracts.

A New Endovesical Instrument. Ned Shnayerson. Am. Jour. Surg., June, 1931, XII, 543-545.

The author has devised a rather novel type of looped snare for endovesical use through an operative cystoscope. It utilizes both the cutting and the coagulating current for the purposes both of excising and coagulating tumors of the bladder. A detailed description of the construction of this new endovesical instrument is presented, with some suggestions as to its use.

Davis H. Pardoll, M.D.

ARTHRITIS

Complications of Gonorrhea: Peri-urethral Abscess, Stricture, Arthritis. Meredith F. Campbell. Am. Jour. Surg., May, 1931, XII, 277-281.

In the more recent consideration of arthritis complicating gonorrhea, the usual conception of its character has changed from that of a mono- to a polyarticular affair. More than two-thirds of the cases at Bellevue Hospital were polyarticular. It is the least frequent of the common complications of gonorrhea, occurring in approximately from 2 to 4 per cent of the cases. Males are more frequently affected. A joint once involved is most likely to be the site of future arthritic changes if urethral reinfection occurs. Trauma and unusual joint activity predispose to gonorrheal arthritis. In hospital practice, the lower extremities are involved in a ratio of four to one, in preference to the upper. The lesion occurs most frequently during the second or third week of the urethral infection. When concomitant with active urethritis, the diagnosis is rather simple. On the other hand, when the exciting organism is not demonstrable, greater diagnostic difficulties are encountered.

In discussing the symptomatic treatment of this condition, the author urges immobilization of the joint or the application of a partial erythema dose of roentgen-ray exposure (from 10 to 25 per cent of a S.E.D., with copper and aluminum filters, and cross-firing of the joint). Relief was obtained by the first X-ray treatment in 22 of the 27 cases so treated.

Davis H. Pardoll, M.D.

BACTERICIDAL EFFECT

On the Influence of the Incubating Time of a Bacterial Culture on its Susceptibility to Roentgen Rays. E. Sulger. Strahlentherapie, 1930, XXXVI, 546.

Cultures of *B. pyocyaneus* were exposed to roentgen rays (120 K.V. effective, 0.33 Zn + 0.2 Al, 10 cm. F.D.) after remaining in the incubator from 0 to 48 hours before irradiation. It appeared that cultures which had been in the incubator up to three hours were much more sensitive to roentgen rays than those which had stayed there longer. The lethal dose for cultures irradiated after having remained in the incubator for about seven hours was about twice as high (10,000 r) as that for cultures having remained there only three hours. No explanation is offered for this observation.

E. A. POHLE, M.D., Ph.D.

BLOOD CHANGES

Further Observations on the Effect of X-rays on Tissues of Mesenchymal Origin. Alessandro Vallebona and Mario Capocaccia. Radiol. Medica, October, 1930, XVII, 1188-1192.

The authors have set out to find whether the changes noted in the blood and in the hematopoietic organs, following administration of X-radiation over the whole body, are due to a direct action of the radiation or to its indirect action, resulting in necro-hormonic influences brought about by extensive lesions of all the organs.

They have irradiated only the right posterior leg of rabbits, the total dose being 1,200 r. Histologic examinations were done one and two weeks after irradiation. No changes were found in the marrow of the irradiated bones, with the exception of a reduction in the number of polymorphonuclear leukocytes and a slight decrease in myelocytes.

The authors draw the following conclusions: (1) Lesions of hematopoietic organs caused by X-rays are more serious, the greater the field of irradiation; (2) in both experimental conditions the elements more sensitive to the action of X-rays are the polymorphonuclear leukocytes.

L. MARINELLI.

BONE (DIAGNOSIS)

Fracture of the Tibia into the Knee Joint. Paul P. Swett, S. H. McPherson, and M. M. Pike. New England Jour. Med., April 9, 1931, CCIV, 749-756.

There is an increased incidence of fractures of the tibial tuberosities, especially the external tuberosity. So frequently is this caused by automobiles striking persons in the upright position that it has been called by Cotton and Berg, the "fender fracture." By some it is called the "bumper fracture." Auto accidents caused 68 per cent of the fractures in this report, and of these, 61 per cent were external tuberosity fractures.

The treatment of these injuries appears to be on an insecure basis, which is unfortunate because marked disability is likely to result from inadequate treatment. Possibility of extensive damage to lateral ligaments must be borne in mind and immobilization maintained long enough to allow this ligamentous damage to heal.

W. W. WATKINS, M.D.

Osteitis Fibrosa Cystica in the Region of the Hip Joint. Gross-Albenhausen. Fortschr. a. d. Geb. d. Röntgenstr., January, 1931, XLIII, 95.

This is a case report of osteitis fibrosa cystica, involving the posterior portion of the acetabulum and a considerable part of the ischial rami, with traumatic dislocation and subsequent central dislocation following reduction of the former. The differential diagnosis, particularly towards infestation with echinococci, is discussed. The final diagnosis

was made chiefly by exclusion of echinococci on the basis of serologic investigation.

H. A. JARRE, M.D.

Fractures of the Tuberosities of the Tibia. Harold G. Lee. New England Jour. Med., March 19, 1931, CCIV, 583-594.

Condylar fractures are serious injuries and are becoming more frequent. They occur either as indirect fractures from a fall, transmitting the weight of the body through the femur to the tibial condyles, or as direct fractures from local violence, such as being struck by an automobile while standing. Immediate recognition and treatment are essential; however a most careful study by X-ray should first be made. The best possible reposition of fragments, especially those of the inner tuberosity, should be obtained. Some permanent damage must be expected in all fractures of this type, but such disability should be reduced to a minimum.

W. W. WATKINS, M.D.

BONE (THERAPY)

Plastic Bone Repair after Therapeutic Irradiation: Report of a Case. Oscar Lee Miller. Jour. Bone and Joint Surg., April, 1931, XIII, 329-340.

A seven-year-old boy had surgical removal of a mass in the tibia, followed by the insertion of "several tubes" of radium for a condition diagnosed sarcoma but now believed to have been bone cyst.

Seven months later localized osteomyelitis had developed, and two and one-half years after the first operation, unsuccessful bone graft was attempted.

Six months later a new graft succeeded, and the author feels that this indicates the wisdom of withholding operation for a considerable time in cases of radium or X-ray injury to the bone.

PAUL C. HODGES, M.D.

BONE DISEASES (DIAGNOSIS)

Further Contributions to the Knowledge of Skeletal Alterations in Tabes Dorsalis. Mario Camplani. Radiol. Medica, September, 1930, XVII, 1048-1053.

The author presents a case of tabes dorsalis in a syphilitic patient who shows, besides the more or less characteristic anomalies of the vertebral column, an extensive callus involving the malleolus of the right leg. In view of the findings, it is affirmed that there is no substantial difference, from the radiologic point of view, between tabetic spondyloarthropathy and spondyloarthropathy deformans.

L. MARINELLI.

Loss of Bone Salts during Scurvy. Editorial. Jour. Am. Med. Assn., June 13, 1931, XCVI, 2038.

In the class of deficiency diseases involving the integrity of the bones is scurvy. In addition to hemorrhages that occur as the disease progresses is a failure of the normal deposition of calcium and phosphorus in the bones in spite of the fact that the diet may contain both these elements. A recent study of the replacement of the bone salts in healing scurvy has been made by Salter and Aub.

In healing scurvy the epiphyseal line was especially well marked, indicating a deposition of salts in the zone of rapid calcification. Furthermore, the cancellous tissue of the epiphysis and diaphysis was stained, the pink trabeculæ extending a short way into the medullary cavity. In addition, the shaft was colored by the dye distal to the epiphysis, though not as deeply as were the trabeculæ.

Bones of animals receiving no Vitamin C remained unstained by the dye in spite of the fact that the experimental ration contained calcium and phosphorus.

The demonstration that this derangement affects the storage of bone salts in the trabecular tissue as well as the deposition in the epiphyseal region is a contribution of considerable importance.

C. G. SUTHERLAND, M.D.

Dyschondroplasia. T. P. Noble. Jour. Bone and Joint Surg., April, 1931, XIII, 269-272.

Apparently using the term as synonymous with "multiple osteocartilaginous exostoses," the author describes a case in which the lesion involved the lower end of the femur and eventually suffered sarcomatous degeneration.

Twenty-four of the male members of the patient's family are known to have been affected with dyschondroplasia.

PAUL C. HODGES, M.D.

About the Echinococcus in Bones. Leon Akselrad. Röntgenpraxis, May 15, 1931, III, 436-442.

An echinococcic cyst in a bone is roentgenologically represented by an alveolar structure; multiple small cysts are usually found with destruction of areas of bone. The roentgenologic diagnosis is very difficult, only five cases having been correctly diagnosed from clinical observation and roentgenologic examination. In many other cases, on operation, autopsy or the laboratory have made the right diagnosis. A trauma seems to precede the development of echinococcic cysts in the bone. Their growth is very slow, often from 18 to 20 years' duration.

The roentgenologic examination usually allows a differentiation from chronic osteomyelitis, syphilis, tuberculosis, or actinomycosis. The picture is rather characteristic, showing larger and smaller areas of destruction of irregular configuration, with sharp edges and dense shadows of the dividing bony wall between the single cavities. An osteitis fibrosa cystica usually shows a rarefaction of the bone, and the cysts are not so sharply defined. However, the differential diagnosis between echinococcic cyst on one side and osteitis fibrosa cystica, enchondroma, and chondrosarcoma is not always possible. The intracutaneous test (Casoni) with echinococcic fluid is a dependable clinical diagnostic means. Dependence cannot be placed upon eosinophilia. The case described by the author is unusual, inasmuch as it shows a single large area of bone destruction in the left os ilium.

H. W. HEFKE, M.D.

BONE DISEASES (THERAPY)

A Case of Osteitis Fibrosa Cystica Associated with Paget's Disease of the Skull. Angelo Santoro. Archivio di Radiologia, March and April, 1931, VII, 193-203.

This is a case report illustrating the fact that the radiographic findings of von Recklinghausen's and Paget's disease may occur in one patient. This one presented osteitis fibrosa, with cyst formation in the radius, the acromion, the ilium, and the maxillary sinus, and Paget's disease of the skull. There was no proof by biopsy.

E. T. LEDDY, M.D.

Human Bite Infections of the Hand, with a Study of the Routes of Extension of Infection from the Dorsum of the Hand. Michael L. Mason and Sumner L. Koch. Surg., Gynec. and Obst., November, 1930, LI, 591.

With the exception of furuncles and carbuncles there are no infections which so commonly involve the dorsal aspect as those resulting from human teeth. The article is well illustrated by drawings and roentgenograms, showing the extent and avenues of the infection. A *résumé* of the literature is given. Most frequently the fist is doubled and the skin, with the extensor tendons, is stretched tightly over the joint. The contact with the tooth usually penetrates the joint cavity. The hand is then extended and this allows the infectious agent to be retained in the joint space, the dorsal subcutaneous space, and the dorsal subaponeurotic or subtendinous space. After entrance into the subcutaneous space the extension of the infection is determined by the anatomical arrangement of the tissues. This is well discussed and a description of injection experiments is given. The clinical course is

given and in 10 of the authors' 15 cases, bone and joint involvement took place. Under the heading of "treatment," the following paragraph is noted: "A word of warning may be in place with regard to the interpretation of roentgenograms in these cases. Not infrequently the surgeon or radiologist forgets how quickly atrophy of disuse makes itself apparent by the absorption of lime salts from the bones of the hand. A diagnosis of osteomyelitis and bone destruction has been made on several occasions when slight infection was present and the process of rarefaction was mistaken for infection."

Bite infections are prolonged and difficult to clear up. The treatment depends on the appreciation of the location and extent of the infection. Unless such infections are drained early and adequately, bone, joint, and tendon involvement are certain to occur and to lead to extensive impairment of function.

D. S. CHILDS, M.D.

THE BRAIN

Diagnosis of Brain Tumor. H. D. McIntyre. Ohio St. Med. Jour., December, 1930, XXVI, 1011-1022.

This is a very complete discussion, with a number of excellent case histories, and only that portion of the paper which refers to X-ray studies is abstracted. A thorough discussion of the general symptoms includes headache, vomiting and dizziness, choked disc, psychic mental changes, convulsions, changes in pulse, respiration, and temperature, and changes in spinal fluid pressure.

Ventricular encephalography is mentioned, stress being laid upon the caution that it should be used only when other methods of locating the tumor have failed. Lumbar encephalography is discussed and its advantages stated as follows: (1) Not being a surgical procedure it can be done by the neurologist; (2) there is no difficulty in looking for the lateral ventricles when they are distorted, as is the case with ventricular encephalography; (3) the needle does not traverse brain tissue with consequent danger of hemorrhage; (4) one can usually fill all the subarachnoid space, including the cisterns and sometimes the ventricles; (5) there is practically no mortality. Tumors above or below the tentorium can usually be differentiated by this method.

W. W. WATKINS, M.D.

Pneumo-ventriculography in Two Cases of Cerebral Affections. Mario Santoro. Radiol. Medica, September, 1930, XVII, 1054-1062.

This is a description of two cases in which ventriculography led to the diagnosis of internal hydrocephalus and tumor of the anterior region of the right hemisphere. The author is of the opinion that this is a very valuable procedure, in spite of its technical difficulties. Dandy's and Bingel's methods were found equally successful.

L. MARINELLI.

CANCER (DIAGNOSIS)

Cancer of the Prostate. Channing S. Swan. Urol. and Cutan. Rev., June, 1931, XXXV, 355-358.

Adenocarcinoma is believed to be responsible for 20 per cent of all the cases of enlarged prostates, after the acute inflammatory group is excluded. Since most prostatic carcinomas originate in the posterior lobe, the importance of rectal examinations on men over 40 years of age can not be overestimated. While the most frequent symptoms observed in this condition are dysuria and frequency of urination, the initial symptoms may occur in other than the genito-urinary tract. Pain in the thighs and back is noted fairly early in some cases. The author believes that gross hematuria is practically never a first symptom in cancer of the prostate and that it occurs far less often than in the benign cases. Reten-

tion of urine, loss of weight, and root pains, as a result of nerve involvement, may be observed during the course of the disease, rarely as initial symptoms. At times, however, roentgenograms made of the pelvis and spine, because of pains, will reveal extensive metastatic lesions as a result of a primary carcinoma of the prostate.

The author is of the opinion that carcinoma is not infrequently present and unsuspected in association with benign hypertrophy of the prostate. Extension of prostatic carcinoma rarely goes to the rectum because of the thick fascial planes separating the prostate from the rectum. The bladder, however, is often the site of an extension from the prostate.

In regard to the treatment of prostatic carcinoma, the following plans are available: (1) Intermittent catheterization and palliation; (2) operative procedures; (3) the use of X-ray and radium. In the operative group we have suprapubic cystotomy, intra-urethral removal of obstructive nodules, suprapubic prostatectomy, and perineal prostatectomy. Radium can be applied to the prostate by perineal dissection, or by reaching the prostate indirectly by placing radium capsules in the urethra or in the rectum.

J. N. Ané, M.D.

Carcinoma in Osteomyelitis. Edward B. Benedict. Surg., Gynec. and Obst., July, 1931, LIII, 1-11.

Twelve cases are taken from the records at the Massachusetts General Hospital, in which carcinoma was found in cases of old osteomyelitis. While this condition is not unknown, it is considered exceptionally rare. These twelve cases are out of 2,400 cases of osteomyelitis. Eight of them were in the tibia, three in the foot, and one in the femur, while the largest number of cases of osteomyelitis were in the latter. Amputation was done nine times and radical excision of the growth, twice.

Diagnosis may be very easy or very difficult; however, it is especially difficult when the lesion is deep-seated, and in these cases biopsy or perhaps X-ray examination is indicated, although the author states that but one out of his twelve cases showed the X-ray appearance typical of carcinoma. He states that the disease is of the slow-growing epidermoid variety, usually without metastasis in the groin, and the prognosis is favorable.

Donald S. Childs, M.D.

Carcinoma of the Prostate: Unusual Metastases. Miley B. Wesson. Am. Jour. Surg., June, 1931, XII, 537-542.

Four interesting cases of prostatic cancer are reported, all of which were beyond the possibility of a cure before they were diagnosed as such. Cases of backache should not be routinely diagnosed as sacro-iliac slip nor manipulated for fear of fracturing a pathologic femur already weakened by metastatic carcinoma. Carcinoma of the prostate gland should be considered in any male past fifty, who complains of an unexplained persistent backache. In the cases reported, the lung metastases failed to cause subjective symptoms; those in the vertebræ manifested themselves in persistent backache, while those in the pelvis and the femur were silent until fractures occurred.

The treatment should be conservative, surgery being resorted to only as a final measure and for symptomatic relief alone. Deep X-ray therapy should be given routinely, as bone metastases so treated may remain symptomless subjectively for a period of eleven years or more.

Every complete physical examination should include a rectal examination as well, if the above conditions are to be recognized early and treated with any degree of success.

Davis H. Pardoll, M.D.

Febrile Symptoms in Carcinoma of the Colon. L. Laureati. Policlinico (Sez. Prat.), Feb. 3, 1930, XXXVII, 174-177. (Reprinted

by permission from Cancer Review, 1931, VI, 328.)

In a man of 67 there had been feverish symptoms for about four months before intestinal troubles led to examination and the finding of colonic carcinoma. As no other cause of the fever could be found, the author concludes that it may have been due to toxins produced by the growth. He also suggests that in cases of fever of long duration in elderly persons, in whom no focal infection can be found, cancer should be suspected.

F. Cavers, D.Sc., M.R.C.S.

CANCER (THERAPY)

Radioproteins and Radio-anaphylaxis in Cancerous Patients Treated by Radiation Therapy. Luigi Cappelli. Radiol. Medica, October, 1930, XVII, 1150-1156.

The author has performed some immunological and biochemical tests upon cancerous patients who have undergone radium treatment. His conclusions may be summarized as follows: (1) The proteins of neoplastic growths liberated by radiotherapy are divided, *in situ*, by the action of proteolitic enzymes in amido-acids and their sub-products, and only as such do they pass into the blood to be routinely eliminated; (2) if this be assumed, the regression of tumors does not give rise to any radioproteins or radio-anaphylaxis. These terms have, therefore, no reason to exist, because the human body, on account of its enzymatic resources, seems to be able to prevent the flow in the blood stream of toxic substances, originating from tumor disintegration.

L. Marinelli.

Etiologic Factors in Carcinoma of the Cervix. Frank R. Smith. Am. Jour. Obst. and Gynec., January, 1931, XXI, 18-25.

The author, following a careful statistical analysis of 226 cancer patients and 202 control patients at the New York Memorial Hospital, draws the following conclusions:

(1) Parturition with its resulting damage to the cervix is a generally accepted etiologic factor in cancer of the cervix. This factor increases in importance with the number of pregnancies.

(2) The incidence is known to be higher in the poorer classes.

(3) There are five additional factors: *(a)* Length of time between marriage and first delivery, with the suggestion of a possible field for investigation as to contraceptives; *(b)* use of lysol douches; *(c)* more than one instrumental delivery; *(d)* dry labor, and *(e)* untreated cervical lesions, as manifested by leukorrhea.

(4) It can certainly be considered that when two or more of these additional factors are present with the known factors of parturition and poverty, the incidence of cancer of the cervix is increased.

(5) Menstruation is not shown to be a factor in carcinoma of the cervix.

Jacob H. Vastine, M.D.

A Comparison of the Results of Surgery and of Radiation in the Treatment of Cancer of the Cervix: Analysis of 200 Cases Subjected to Radiation Treatment. Thomas E. Jones. Am. Jour. Obst. and Gynec., February, 1931, XXI, 187-196.

Notwithstanding the numerous articles which have been written and the publicity which has been given this subject, the cases presenting themselves at the Cleveland Clinic, in 1929, were just as far advanced as the cases seen in 1920.

Investigation has disclosed that hysterectomy for carcinoma of the cervix is still in vogue in the smaller localities, while it has practically been discarded in the larger centers. Wertheim, by his radical operation, was able to cure 18.02 per cent of the cases of cervical carcinoma. He found only 48 per cent of the cases operable, so he in reality cured only 9 per cent of the cases which came to him. Jones quotes the following men as preferring irradiation to surgery in the treatment of carcinoma of the cervix: Norris, Crossen,

Kelly, Ward, Lynch, W. J. Mayo. The opinions of these eminent men cannot be disregarded, and it is reasonable to say that until some better treatment is discovered, radiation therapy is the next best treatment for cancer of the cervix.

With regard to etiology, the author emphasizes the relation between chronic irritation and cancer. In a series of 5,000 cases studied by Graves, in which cervical repair had been done, only four patients later developed malignancy.

Diagnosis is considered. The author feels that biopsy is harmless and is indicated in doubtful cases. Classifications, as described by Broders, Martzloff, and Hueper, are discussed, and Jones believes them to be valuable in prognosis.

At the Cleveland Clinic, the technic of radium therapy is as follows: The author uses radium, filtered through 1.5 mm. of brass, and 3 mm. of rubber, placed in and about the cervix and in the fundus, a total of 3,600 mg.-hr. being given. Roentgen therapy is used externally in all cases.

Such complications as hemorrhage and rectal and bladder symptoms are discussed.

The results are as follows: Jones obtained 25 per cent of five-year cures by irradiation. This includes treatment of practically all cases, advanced as well as the early. It represents cases treated prior to 1925: the technic has been improved since that time. Including the more recent cases, 54 per cent are alive from one to three years following treatment. All patients who could not be traced are regarded as dead. The average duration of life following therapy of the patients who died was fourteen and one-half months.

JACOB H. VASTINE, M.D.

CHEMICAL

Relativistic Theory of the Photo-electric Effect. Part I.—Theory of the *K*-absorption of X-rays. Harvey Hall. Part II.—Photo-electric Absorption of Ultra-gamma Radiation. Harvey Hall and J. R. Oppenheimer. Phys. Rev., July 1, 1931, XXXVIII, 57. (Reprinted by permission.)

Part I.—A strict theory of the absorption of X-rays is developed on the basis of relativistic quantum electrodynamics. The theory is applied to the absorption of X-rays by a Dirac electron in the field of a nucleus. Corrections to the non-relativistic theory are appreciable only for heavy elements, where the present calculations give a *K*-discontinuity 20 per cent smaller than the earlier ones. The agreement with experiment is not improved.

Part II.—The theory is applied to the calculation of the absorption of quanta whose energy is larger than the proper energy mc^2 of the electron. The cross-section for absorption is here given approximately by

$$\sigma \backsim 2 \times 10^{-22} Z^5 \lambda$$

This result is applied to account for the excess absorption over that predicted by the Klein-Nishina formula found experimentally for the gamma-rays of ThC″ by Chao and Tarrant. The theory is in fairly good agreement with experiment for Cu, but disagrees violently with it for Pb. An examination of the approximations made in deriving and applying the theoretical result shows that they cannot have introduced this discrepancy. There is thus a definite conflict between electrodynamical theory and experiment.

Polymerization in Crystal Lattice—Crystal Structure of Trinitoresorcinol and Trinitrophloroglucinol. Eduard Hertel and Kurt Schneider. Ztschr. physik. Chem., Abt. B, 1931, XII, 139-150 (*cf.* Chem. Abs., XXIV, 2924).

Picric acid has four double molecules in its unit cell (*cf.* Bredig and Möller, Chem. Abs., XXIII, 5368). The entrance of a second OH group as in styphnic acid (I) causes the formation of two triple molecules in the unit cell but the entrance of a third OH as in 2,4,6-trinitrophloroglucinol (II) does not continue the "polymerization." I and II are trigonal, probably space group C^3_{3v} but possibly of D^4_{3d}. Their crystal structures are almost identical. The unit cell of each contains six formula weights and has the dimensions for I; $a =$

12.7, b = 22.0, and c = 10.0 Å.U., and for II; $a = 13.4$, $b = 23.6$, and $c = 9.6$ Å.U. The structure of each is built up of two units of 3 $C_6H_3N_3O_8$ or $C_6H_3O_9N_3$ groups in the unit cell. Test for piezoelectrical effects with both was negative. In spite of the far-reaching similarity of the crystalline structure of both compounds they form no series of mixed crystals; the phase-rule diagram shows only an eutectic.

CHEMICAL ABSTRACTS.

X-ray Study of the Gelatinization of Nitrocellulose. Desmaroux and Mathieu. Compt. Rend., 1930, CXCI, 786-788.

X-ray diagrams were obtained and described for films of nitrocellulose which contain various gelatins, such as cyclohexanone, nitroglycerin, and acetophenone.

CHEMICAL ABSTRACTS.

The Absorption of Scattered X-rays and Compton's Theory of Scattering. S. R. Khastgir. Proc. Fifteenth Indian Sci., Cong., 1928, p. 88.

The most significant feature in the comparison of the absorbabilities of the secondary (scattered) and primary X-rays by the method of Barkla and Khastgir (Chem. Abs., XX, 146) is the constancy, over a wide range of wave lengths, of the ratio of the ionizations produced by the secondary and primary beams, when the beams are either *unintercepted* or *intercepted* by similar sheets of an absorbing substance. The two alternative cases recorded are: *A* (not considered here) in which discontinuities in the "intercepted" ratio S′/P′ are obtained, and *B*, the only case giving results at all capable of explanation in terms of Compton's theory of wave length change on scattering, in which the values for the "unintercepted" ratio S/P and the "intercepted" ratio S′/P′ for various wave lengths are found to lie on two parallel horizontal lines without the slightest sign of any discontinuity. Calculations of the ratio S′/P′ were based on C. T. Ulrey's energy-distribution curves (Chem. Abs., XII, 1530). From these curves of Ulrey's, corresponding curves were then constructed for both primary and scattered beams intercepted by an equal thickness of an absorbing material. In the case of the scattered beam, the increased value of the absorption coefficient, corresponding to Compton's wave length change, was used. The presence of an unmodified radiation in the scattered beam was also taken into account. Thus for six voltages, six pairs of distribution curves for the *intercepted* scattered and primary beams were obtained, the ratio of the areas of each pair giving the value of S′/P′ for each voltage. Al and Au were used as absorbers. In both cases, the computed curves (not given) for S′/P′ did not agree with the experimental results of Barkla and Khastgir.

CHEMICAL ABSTRACTS.

Structural Analogies of Binary Alloys of Transition Elements and Zinc, Cadmium, and Aluminum. Walter Ekman. Ztschr. physik. Chem., Abt. B, 1931, XII, 57-78.

Powder X-ray diagrams were obtained of phases of the systems: Fe–Zn, Co–Zn, Ni–Zn, Rh–Zn, Pd–Zn, Pt–Zn and Ni–Cd. All correspond to the interference photograph of γ-brass. These phases represent a valence electron concentration of 21–13, on the assumption that transition elements may be regarded as of zero valence. The homogeneous region for an Fe–Zn phase of this type lies between 19 and 23 atom per cent Fe. The Co–Zn phase and the Ni–Zn phase are homogeneous between 15 and 22 atom per cent Co and 15–19 atom per cent Ni, respectively. C–Zn shows a phase similar to β-Mn in structure. A phase analogous to β-brass was found in the Co–Al system. Calculation of atomic volume indicates that contraction accompanies phase formation.

CHEMICAL ABSTRACTS.

The Mechanism of Separation of Radon from Radio-active Minerals in Liquid Medium. V. I. Sptizuin. Trav. Rad. et Min-

erais Radioactifs Acad. Sci., U. R. S. S., II, 264-271 (*cf.* Chem. Abs., XXIII, 1048).

The basic purpose of this investigation was to find general laws which govern the process of transition of Rn from minerals into liquid media so that with their help the variation in radio-activity of various springs could be explained. As far as the qualitative side is concerned, the results obtained permit the making of satisfactory conclusions. Thus only torianite, a mineral which is found with comparative rarity, has no positive temperature coefficient, and, therefore, it could be said with a sufficient degree of probability that hot springs will be placed in more favorable conditions as to the absorption of Rn than cold ones. This conclusion could not be arrived at by the observation of springs proper because several factors act simultaneously which combine to complicate the situation. No results were obtained on chemical composition of mineral water and radio-activity. It is shown that with typical, purely uranium minerals the concentration of NaCl solution increases considerably the rate of separation of Rn. Samarskite and torianite liberate in NaCl solution the same amount of Rn as in water. In no case is there a considerable decrease in the rate of separation of Rn.

CHEMICAL ABSTRACTS.

Quantitative X-ray Analysis. Copper-silver and Copper-zinc Alloys. Henry Terrey and Eric George Victory Barrett. Jour. Phys. Chem., 1931, XXXV, 1156.

The intensities of the $K\alpha$ radiation in the X-ray emission spectra of Cu-Ag alloys are determined by measurement of their ionizing power, and of Cu-Zn alloys by both the ionization and the "wedge camera" methods. The composition of an alloy can be determined quantitatively by these intensity measurements only when (1) the elements in the alloy are adjacent to one another in the periodic system, and (2) the emission spectrum of any one constituent metal does not fall within the absorption region of any of the others. The $K\alpha_{2,1}$ line of Ag falls within the absorption region of Cu, thus causing a diminution in the intensity of the Ag radiation and a strengthening in the Cu radiation intensity. No absorption of the $K\alpha_{2,1}$ Zn line occurs in the Cu-Zn alloys. For Cu-Ag alloys the relation between intensity and atomic concentration may be represented over a wide range of concentration by: $I_{Ag}/I_{Cu} = M.C_{Ag}/(C_{Ag} + C_{Cu})$; for Cu-Zn alloys the relationship is linear. The so-called "wedge camera" method is developed by the authors for determination of the relative intensities of lines in an X-ray spectrum, being dependent on the measurement of their penetration of an Al wedge.

CHEMICAL ABSTRACTS.

X-ray Study of the Copper End of the Copper-silver System. Roy W. Drier. Ind. Eng. Chem., 1931, XXIII, 404.

X-ray examination of various Cu samples indicates that Ag is not dissolved in the Cu. It is concluded that under ordinary room conditions Ag is not soluble in Cu.

CHEMICAL ABSTRACTS.

Note on the Roentgen Diagram of Collagen (Fiber Period). R. O. Herzog and W. Jancke. Ztschr. physik. Chem., Abt. B, 1931, XII, 228 (*cf.* Chem. Abs., XXI, 1213; K. Herrmann, *et al.*, Chem. Abs., XXV, 632).

The value for the fiber period, about 20 Å.U., for collagen and elastin earlier obtained by Herzog and Jancke has been questioned by Herrmann *et al.*, on the basis of their work on gelatin, which indicates a value of about 9.5 Å.U. Herzog and Jancke emphasize the fact that their preparations from stretched neck ligaments and heel tendons of cattle give much clearer diagrams than they could obtain from stretched gelatin. They obtained sin $\theta/2$ values of 0.107, 0.191 and 0.270. Herzog finds values agreeing with the first and the third but then considers only the first value in arriving at a fiber period of 9.5 Å.U.

CHEMICAL ABSTRACTS.

Methods of Investigating the Intensities of γ-rays. C. D. Ellis and D. Skobeltzyn. Nature, 1931, CXXVII, 125.

The Skobeltzyn method (Chem. Abs., XXIV, 1573) of investigating the intensities of γ-rays depends on observing by the Wilson cloud method the relative number of electrons ejected within a certain angular range by the Compton effect of the different γ-rays; the Ellis and Aston method depends upon the photo-electrical effect. γ-rays of Ra B and C showed intensities of 0.22, 0.46, and 0.26 by the photo-electrical method after passage through 3.5 mm. Pb; the corresponding intensities by the Compton effect were 1, 1.8, and 1.19, respectively. This agreement is as good as can be expected.

CHEMICAL ABSTRACTS.

A Note on the Relative Absorption of the Primary and Scattered X-rays by Silver and Tin. S. R. Khastgir. Proc. Fifteenth Indian Sci. Cong., 1928, p. 88.

The results (not given) of a few absorption experiments show not only that the theory of wave length change on scattering is untenable but that the greater absorbability of the primary radiation, as observed by Gray (Chem. Abs., XVII, 2229) is most certainly due to the *J*-transformation in Ag.

CHEMICAL ABSTRACTS.

The Crystal Structures of the Compounds Formed in the Antimony-cadmium System. Masumi Chikashige and Toshimichi Yamamoto. Anniv. Vol. Dedicated to Masumi Chikashige (Kyoto Imp. Univ.), 1930, pp. 195-199.

An X-ray examination to distinguish the stable and metastable compounds belonging to the Sb–Cd system was undertaken. The compound, SbCd, exists in two modifications, α and β, which have the same space lattices with respect to type and dimension, belonging to the hexagonal system, the base and axial ratio of which are 4.42 Å.U. and 0.78, respectively. The so-called metastable compound, Sb_2Cd_3, is a eutectic mixture of β-SbCd and Cd. (*Cf.* Chem. Abs., XXIV, 1558.)

CHEMICAL ABSTRACTS.

Nature of the Groupings of Radio-active Atoms. E. L. Harrington. Compt. Rend., 1931, CXCII, 414.

The conclusion of Jedzrejowski that the formation of aggregates of radio-active atoms is facilitated by impurities, groups forming around the nuclei of impurities, has been confirmed. But it is found that the impurities are not essential. The absence of aggregates on freshly cut mica is explained in a different way. The aggregates are more numerous around scratches, detached scales, and along edges. Either the groups form at the position observed or they form in the atmosphere. Polar molecules also aid in the formation of groups. The grouping of radio-active atoms which form in mixed gases containing Rn are constituted of the radio-active atoms and polar molecules around a nucleus. It is usually a stable association of ionized radio-active atoms. The beds of polar molecules have a low vapor pressure. The detection of aggregates depends on the number of radio-active atoms as well as the number of polar molecules.

CHEMICAL ABSTRACTS.

X-ray Interference by Di- and Tri-atomic Molecules of Light Gases. H. Gajewski. Physik. Ztschr., 1931, XXXII, 219-221.

Scattering experiments were made, with a Cu radiator, on N_2, O_2, CO_2, NH_3, and the vapors of CS_2 and H_2O. Interatomic distances calculated from the data were compared with those from other types of determinations. The experimental scattering curves were compared with the theoretical curves from the Debye scattering formula.

CHEMICAL ABSTRACTS.

The Structure of Nitrocelluloses. Desmaroux and Mathieu. Compt. Rend., 1931, CXCII, 234-236.

X-ray diagrams of cotton cellulose nitrates containing from 11.35 to 13.9 per cent N all showed distinct circles of diameters indicating reticular distances of 6.6 to 7.5 Å.U., the increase being regular. The trinitrate showed two intense circles corresponding to reticular

distances of 4.5 and 4.0 Å.U., respectively. The product with less than 13.9 per cent N showed two larger circles of lesser intensity, the one containing 12.1 per cent N having two concentric uniform regions which met. An examination of the products by means of the polarizing microscope showed that the coloration of the fiber surfaces was that of a trinitrate, whereas the interior was characteristic of a lower nitrate, indicating heterogeneity.

When Müller diagrams of long-chain paraffins, indicating that the different reticular planes admit of considerable variation in arrangement in respect to variations in temperature, were compared with those of Desmaroux and Mathieu, evidence of an anisotropic structure of nitrocellulose was observed. The interior circle of the Debye-Scherrer diagram of nitrocotton of 13.9 per cent N corresponds to the intense equatorial spots near the center of nitroramie, such spots caused by reticular planes not coinciding with the periodicity in the fiber. It is such a family of planes whose distribution remains periodic when the percentage of N is varied and which suddenly disappears when the nitrocellulose passes to the amorphous state.

CHEMICAL ABSTRACTS.

X-ray Dispersion in Copper Sulphate Crystals. L. J. Nagy. Matematik és Természettud. Ertesitö, 1930, XLVII, 70-77.

The absorption limits of the Cu *K* line were studied by means of a Seemann apparatus on three different oriented surfaces of $CuSO_4$ crystals. Not only the grating space but also the dispersion changes with the reflecting surface. Larger dispersion belongs to larger grating space. No dispersion data agreed with the theoretical value of $\delta = 3 \times 10^{-6}$.

CHEMICAL ABSTRACTS.

Radio-active Metamorphic Phenomena in Fluorspar from Wölsendorf. Luise Goebel. Sitzb. Akad. Wiss. Wien, Abt. I, 1930, CXXXIX, 373-391.

The radio-active "ball" halos of radio-active fluorspar from Wölsendorf are nothing other than aged ring halos as shown by development series studies and range measurements of α-particles. The colloidal nature of the pigments in Wölsendorf fluorspar is shown by use of the ultramicroscope. The colloidal particles are most frequently Ca particles and the color changes according to the size of the particles; small particles correspond to green, larger to blue, violet, etc. The radiations from the radio-active materials probably cause the formation of neutral Ca and F from the fluorspar, as "stinking fluorspar" (containing free F and usually dark colored) is rather common.

CHEMICAL ABSTRACTS.

The Precise Measurements of the *L*-group of the X-rays in the Heavy Elements. Sakae Idei. Science Reports, Tohoku Imperial Univ., 1930, XIX, 1st ser., 559-639.

Complete results are presented of the measurements of the wave lengths of the X-ray lines in the *L-group* for the elements, Ta (73) to U(92). The wave lengths of the stronger lines determined by Firman and Wennerlöf were used as standards. Siegbahn's tube spectrometer was used throughout the experiments. The differences in the values of ν/R for the energy levels, $[L_I L_{II}]$, $[L_I L_{III}]$ and $[L_{II} L_{III}]$ have been calculated from the data given by the emission lines and are compared with the values obtained from the measurements of the absorption edges. The correlation of the experimental data with the process of atom-building has been attempted by the method of the modified Moseley curves, which have been constructed for the elements studied. Regularities in the orders of the intensities as a function of the atomic numbers are discussed.

CHEMICAL ABSTRACTS.

The Fine Structure of the Moseley Curves for the Energy Levels in the Lower Elements. Sakae Idei. Science Reports, Tohoku

Imperial Univ., 1930, XIX, 1st ser., 641-649 (*cf.* preceding abstract).

The fine structure of the Moseley curves for the energy levels in elements of low atomic number has been studied by a simple method proposed by Idei, according to which the curve is assumed to be a straight line, $\sqrt{\nu/R} = a + bZ$, after which the differences between the actual values of $\sqrt{\nu/R}$ and corresponding points on this line are plotted against Z. Such a difference curve is called a modified Moseley curve. Many discontinuities in the curves studied corresponding to the stepwise process of atom-building are brought out in a striking manner. Some considerations are put forward on the screening effect of other electrons.

CHEMICAL ABSTRACTS.

The Fine Structure of the Moseley Curves for the *M*-absorption Edges in the Heavier Elements. Sakae Idei. Science Reports, Tohoku Imperial Univ., 1930, XIX, 1st ser., 651, 652 (*cf.* following abstract).

Discontinuities in the Moseley curves for the L-absorption edges and for some emission lines in the L- and M-series at Pt(78) and near Th(90) were reported in a previous paper. Similar discontinuities have been confirmed for the M-absorption edges by the method of the modified Moseley curves.

CHEMICAL ABSTRACTS.

The Fine Structure of the *K*-absorption Spectrum of Selenium. Sakae Idei. Science Reports, Tohoku Imperial Univ., 1930, XIX, 1st ser., 653-658.

Measurements of the fine structure of the K-absorption edge of Se are reported. The effect of chemical combination on the principal K-absorption limit has been found to be negligibly small. Suggestions which have been made as to the possible origin of such structures will require data from a larger number of elements for confirmation.

CHEMICAL ABSTRACTS.

Protective Lead Thickness in the German Protective Recommendations. J. H. van der Tuuk and W. H. Boldingh. Fortschr. a. d. Geb. d. Röntgenstr., 1930, XLI, 965.

The conclusion is drawn that the International recommendations regarding Pb thickness for X-ray protection are preferable to those of the German Röntgen Society. Dosage measurements were made to obtain the necessary data.

CHEMICAL ABSTRACTS.

Protective Lead Thickness in the International and in the German Protective Recommendations. R. Glocker. Fortschr. a. d. Geb. d. Röntgenstr., 1930, XLI, 967.

The author refers to the work of van der Tuuk and Boldingh (see above), and points out the difference in principle used in deciding upon the international and the German recommendations. A decrease in thickness from 5 mm. to 4.5 mm. for 200–220 K.V. appears desirable.

CHEMICAL ABSTRACTS.

A Note on the Mineralogy of Coal as Suggested by X-ray Examination. Henry Briggs. Colliery Guardian, 1929, CXXXVIII, 638-640.

Mineral impurities in coal are classified under four heads: (1) Those existing in the coal substance, and so finely disseminated through it that they cannot be extracted by any known physical process; (2) those forming layers, streaks, or flakes lying in the bedding planes; (3) those forming streaks, flats, flakes, or plates, usually at angles approaching the right-angle, and (4) particles, crystals, or irregular masses, large or small, scattered, apparently promiscuously, through the coal. The first is discernible only in the radiograph of a coal band as a uniform and a featureless cloudiness of the clearest portions, while the other three varieties are sharply silhouetted in an X-ray photograph, and their manner of occurrence is still more clearly presented by

the stereoscopic method of Kemp and Thomson. A review is made of characteristics of the mineral impurities, and the low ash content (compared to that estimated from the plant source of the coal) is explained. X-rays provide refined methods of qualitative analysis not previously available and at the same time enable the manner of distribution of these foreign substances to be studied without destroying the sample.

CHEMICAL ABSTRACTS.

The Regularities of X-ray Spark Spectra. Sakae Idei. Science Reports, Tohoku Imperial Univ., 1930, XIX, 1st ser., 551-558.

The values of $\triangle \sqrt{\nu/R}$ and $\triangle \nu/R$ between the so-called spark lines in the X-ray spectra and their main line have been studied as functions of the atomic number, and it is found that $\triangle \sqrt{\nu/R}$ is nearly constant and $\triangle \nu/R$ varies linearly with the atomic number. By these regularities it was possible to correlate certain spark lines found by several investigators.

CHEMICAL ABSTRACTS.

Hydroxide Systems in Iron Oxide Colors. Hans Wagner. Kolloid-Ztschr., 1931, LIV, 310-314 (*cf.* Chem. Abs., XXV, 221).

X-ray photograms showed the following structures for various commercial colors: (1) Bright ocher Fe_2O_3, goethite lattice; (2) Mars yellow containing $CaCo_3$ and $CaSO_4$, $CaCO_3$ lattice; (3) Mars yellow free of chalk, no lattice; (4) Tuscany sienna, goethite lattice; (5) $Fe(OH)_3$ from $FeCO_3$ weathering, goethite lattice; (6) $Fe(OH)_3$ from sericite weathering, mica lattice. Ochers or citron yellows are characteristic of colors composed of monohydrate. Microscopic examination reveals (1) and (3) containing very fine needles with a strong tendency to agglomerate; (4) consists of coarse grains, splinters, and angular particles which are transparent in a bright field and shine in polarized light; (2) and (3) resemble (4) more closely than (1). Ochers may be classified according to the adsorption of basic dyes, such as brilliant green, by the ocher substrate, usually a mixture of Al_2O_3, SiO_2 and H_2O. German ochers adsorb the dye irreversibly (chemosorption) and the substrates are Al_2O_3-SiO_2 gels; French ochers adsorb the dye reversibly (lyosorption) and the substrates are kaolins. The classification is not absolute and transition types of ocher exist.

CHEMICAL ABSTRACTS.

The Ultra-violet Rays of Artificial Light. H. Butz and Th. Bottger. Ztschr. Tierzucht. Zuchtungsbiol. Tierernähr., 1931, XXI, 48-72.

The question of the usefulness of the rays in the prevention and cure of rickets is reviewed, with special reference to animal husbandry practice. Data are presented showing that light treatment is without effect upon the hemoglobin content of the blood of rabbits.

CHEMICAL ABSTRACTS.

Comparison of the Crystal Structures of an Addition and a Substitution Compound. Eduard Hertel and Kurt Schneider. Ztschr. physik. Chem., Abt. B, 1931, XII, 109-114 (*cf.* Chem. Abs., XXIV, 2924).

The crystal structures of aniline picrate (addition compound) and 2,4,6-trinitrodiphenylamine (substitution compound) showed an extensive analogy, according to X-ray analyses. They agreed with respect to the spatial group and two main identity periods. The difference in the third period may be due to a specific orientation of the molecule in this direction, and to spatial requirements of the H_2O molecule, by which addition and substitution compounds differ.

CHEMICAL ABSTRACTS.

The Crystal Structure of the Inert Gases. II.—Krypton. A. Nasini and G. Natta. Atti accad. Lincei, 1930, XII, 141-147.

The method of powders was used as with Ne (Chem. Abs., XXIV, 3410, 4198). The crystal structure of Kr was determined at the

temperature of liquid N_2. It is a face-centered lattice having 4 atoms with side 5.78 Å.U., vol. 193×10^{-24} c.c., density 2.83. The radius of the atom as determined by X-rays was compared with that determined by viscosity measurements for Ne, A, Kr, N_2, CO, NH_3, H_2S, HBr, Xe, PH_3, HI, the ratio of the value found by these two methods varying from 1.28 to 1.35, indicating that these two methods of measurement are concordant.

CHEMICAL ABSTRACTS.

The Question of the Disturbance of the Equilibrium between Radium B and Radium C in Preparations Freed from Residual Emanation. Karl Marbach. Sitzb. Akad. Wiss. Wien, Abt. IIa, 1930, CXXXIX, 231-239.

The usual methods of removing emanation from preparations have been questioned as to whether or not they disturbed the Ra B–Ra C ratio (*cf.* Braddick and Cave, Chem. Abs., XXIII, 1048). Removal of emanation by the usual short-time washing with alcohol, heating to 400°, or blasting with a strong current of air is believed rarely to disturb the Ra B–Ra C ratio as much as 1 per cent.

CHEMICAL ABSTRACTS.

Radium-bearing Minerals from Great Bear Lake, Northwest Territories. Hugh S. Spence. Canadian Dept. Mines, Mines Branch, Memorandum Series, No. 48, 1931 (4 pages).

Analyses of two pitchblende samples showed U_3O_8 56.91, 63.94; Th nil; V_2O_5 trace, nil; Cu 0.70, 0.66; Ni trace; Co 0.13, 0.10; PbO 12.00, 12.13; Bi 0.18, trace; As 0.15, 0.14; Fe 1.01, 0.77; S 2.08, 0.90 per cent; Ag 1.41, 1.72; Au 0.19 oz. per ton, trace. U_3O_8 content of eight samples was 27.88–83.90 per cent, equivalent to 70.79–213 mg. per ton. Quartz was the principal impurity. Pb was present up to 11.25 per cent. Flotation tests showed only little improvement in grade with a loss of 7.51 per cent of the U_3O_8.

CHEMICAL ABSTRACTS.

Applications of X-rays to the Study of Metals. James B. Friauf. Rev. Sci. Instruments, 1930, I, 361-396.

A general popular account is given, including the subjects of radiography, metal crystals and alloys, orientation, grain size, internal strain, thermal expansion, fiber structure, and the effects of mechanical and heat treatment. A bibliography of 44 references is appended. Notice is given of the publication of a complete bibliography on X-ray studies of ferrous materials involving more than 300 references.

CHEMICAL ABSTRACTS.

Effect on the Properties of Soda-lime-silica Glass of Repeated Melting in Platinum. The X-ray Pattern. W. E. S. Turner. Jour. Soc. Glass Tech., 1930, XIV, 351-353 T (*cf.* Chem. Abs., XXV, 788).

No change in physical properties was observed unless a chemical change was produced by the repeated meltings in Pt.

CHEMICAL ABSTRACTS.

Scattering of Hard γ-rays (II). L. H. Gray. Proc. Roy. Soc. (London), A130, 1931, pp. 524-541.

The relative scattering powers of Mg, Al, Cu, Zn, Cd, Sn, and Pb for Ra C γ-rays filtered through 4 cm. of Pb and for Th C γ-rays filtered through 3 cm. of Pb have been investigated by observing the ionization produced by radiation scattered within the angular range 10–30°. For Ra C γ-rays the decrease of scattering power per extranuclear electron from Mg to Pb is 2 per cent; for Th C γ-rays there is a gradual increase of about the same amount, but this is of the order of magnitude of error in the application of the correction for reabsorption of scattered radiation in the scatterer. Therefore, these measurements establish the fact that the binding forces in heavy elements do not influence appreciably the scattering power of extranuclear electrons for radiations of energy corresponding to 2×10^6 electron volts.

CHEMICAL ABSTRACTS.

X-ray Distinctions between Magnesite and Dolomite. Franz Halla. Monatsh., 1931, LVII, 1-8.

Powder spectrograms of very pure samples of the minerals from various sources have been utilized to establish their structure. They can be distinguished with certainty in this manner. The parameters of the rhombohedral unit cell of $CaMg(CO_3)_2$ are a 6.050 $\pm$ 0.004 Å.U., and $\alpha = 46°54'$. Detailed studies and reproductions are given.

CHEMICAL ABSTRACTS.

The Formation of Molecular Aggregates in Radon-gas Mixtures Containing Polar Molecules. E. L. Harrington and O. A. Gratias. Phil. Mag., 1931, XI, 285-296.

The formation of aggregates of active deposit atoms in gases containing radon in the presence of HCl, SO_2, EtOac, *o*-nitrotoluene, *p*-nitrotoluene, $ChCl_3$, CCl_4, MeOac, and acetone was studied by the centrifuge, the photographic, and the ultra-microscopic methods. The previous work on air-radon-H_2O and water-free air-radon mixtures was confirmed. Aggregate formation in the presence of HCl is of average magnitude; it is very large in the presence of *o*-nitrotoluene. Polar molecules favor the formation of aggregates in radon-gas mixtures.

CHEMICAL ABSTRACTS.

Discoloration of Glass and Some Minerals by Beta and Gamma Rays. Josef Hoffmann. Sitzb. Akad. Wiss. Wien, 1930, CXXXIX, Abt. II A, 203-230.

Many different glasses and mineral specimens were irradiated with β- and γ-rays from 610 mg. $RaCl_2$ until no further color change took place. Many samples were also irradiated with ultra-violet rays from a quartz Hg-vapor lamp. When heated, most of the samples lost the color caused by irradiation but in some cases heating caused a change in color. For Mn-free glasses the irradiation colors are yellow, reddish yellow, brown, reddish brown, gray, and blackish. Alkali metal atoms are most commonly the cause of color; then Pb, Ba, and Zn and certain heavy metal atoms follow. Only Pb glasses produce a reddish shade as a ground color. Pb glasses are recognizable because they show fluorescence under ultra-violet light. Glasses relatively unstable because of high basicity, heavy metal oxide components, several different acid components, etc., frequently show first a gray color, then a brown, and finally a blackish color. The Mn glasses present a unique problem which will be considered in a later paper. Violet is a common final color with Mn glasses.

CHEMICAL ABSTRACTS.

The Distribution of Radon between Liquid and Solid Phases of Water and of Benzene. Franziska Witt. Sitzb. Akad. Wiss. Wien, 1930, CXXXIX, Abt. II A, 195-202.

Experiments showed that the quantity of Rn in the solid phase depends on the rate of freezing of H_2O or C_6H_6 solutions of Rn. Exhaustive experiments failed to show any simple relationship between rate of freezing and Rn content but did show that when C_6H_6 solutions are frozen very slowly Rn is not present in the solid phase. The phenomenon seems to be one of occlusion rather than solubility. The fact that even very slow freezing did not reduce the Rn content of ice below from 3 to 4 per cent is probably due to the air bubbles enclosed in the ice.

CHEMICAL ABSTRACTS.

The Structure of Hydrogen Sulphide and Hydrogen Selenide. G. Natta. Nature, 1931, CXXVII, 129.

A cubic lattice was found with face-centered distribution for S and Se atoms. The density of H_2S was 1.166, H_2Se 3.45. The side of the cell (a) was found to be 5.778 Å.U. for H_2S and 6.020 for H_2Se. Considering both as ionic compounds, the most probable space group is Oh^5, a fluorite type shown by Li_2S.

CHEMICAL ABSTRACTS.

Experiments on the Luminescence of Zinc Sulphide and Diamond under the Influence of Radio-active Radiation. Berta Karlik. Sitzb. Akad. Wiss. Wien, 1930, CXXXIX, Abt. II A, 509-519.

The decrease in luminescence of a ZnS screen under the effect of pure α-radiation from Po was measured. The results are compared with those of Marsden (Chem. Abs., V, 242). A filter was found which separates the two bands in the emitted light; the individual variations of these bands were studied. Another sample of ZnS of smaller scintillating ability showed a smaller decrease in luminescence. The Rutherford formula was found not to fit the data when applied to the individual bands. A saturation value for γ-radiation was found. This was shown not to be caused by regeneration in the dark. Experiments were made on the effect of α- and γ-radiations on a sample of diamond. The results were similar to those obtained with ZnS. A description is given of the method by which the ratio of luminescence intensity to particle density was controlled.

CHEMICAL ABSTRACTS.

An X-ray Study of Mannitol. George W. McCrae. Nature, 1931, CXXVII, 162, 163.

Results for *d*-mannitol are space group Q^4; $a = 8.66$ Å.U.; $b = 16.58$ Å.U.; $c = 5.50$ Å.U.; calculated density 1.522; 4 molecules per cube.

CHEMICAL ABSTRACTS.

An Explanation of the Swelling Effect of Thiocyanates on Cellulose: Compounds of Cellulose with Neutral Salts. J. R. Katz and J. C. Derksen. Rec. Trav. Chim., 1931, L, 149-152.

The swelling of stretched ramie fibers by concentrated LiSCN solutions has been investigated by the X-ray method. When solutions more concentrated than $3LiSCN:1H_2O$ are used, the fibers show an altogether new roentgen spectrum for cellulose. With solutions of lower concentrations, the salt appears to be absorbed on the surface of the micelle, without any change in the structure of the latter. With higher concentrations, presumably additional products are formed on the O atoms of the cellulose, and these compounds are responsible for the new X-ray patterns. Cellulose can be mercerized by solutions of salts of high solubility, the degree of mercerization increasing with the salt concentration and the length of heating.

CHEMICAL ABSTRACTS.

Experiments on Radiothermoluminescence. Frances G. Wick. Sitzb. Akad. Wiss. Wien, 1930, CXXXIX, Abt. II A, 497-508; Jour. Opt. Soc. Am., 1931, XXI, 223-231.

Quantitative observations were made of the thermoluminescence, after irradiation with Ra, of synthetic $CaSO_4$ with added Mn and of samples of fluorite. The photo-electric method of Urbach was used; experimental details are given. The $CaSO_4$ used showed a single intensity maximum which was lowered by pressure applied either before or after Ra irradiation. Fluorite showed a series of maxima which are ascribed to the rare earths on the basis of a spectroscopic examination. These maxima also were lowered or destroyed by pressure, while a blue band was relatively intensified by pressure applied before irradiation. The natural thermoluminescence of the fluorite samples was examined. The effect of Ra irradiation on the substances investigated is similar to that obtained with roentgen rays.

CHEMICAL ABSTRACTS.

X-ray Examination of the Crystal Structure of Resorcinol. A. N. Sarkar. Proc. Fifteenth Indian Sci. Cong., 1928, p. 92.

X-ray examinations of crystals of catechol, resorcinol (I) and hydroquinone were undertaken with a view to confirm the structure of the benzene nucleus determined by Bragg from the examination of $C_{10}H_8$. The data ob-

tained from the powder photographs of crystals of I were insufficient for the determination of molecular structure, but it was found that the space group is C_{2v}^{10} and the molecules are asymmetrical. From certain observed accidental interference minima, not characteristic of group C_{2v}^{10} certain relative arrangements of the four types of molecules in the unit all were deduced. Sarkar's deductions as regards space group and number per cell confirm Bragg's conclusions, but Sarkar suggests a different arrangement of molecules.

CHEMICAL ABSTRACTS.

Cosmic Radiation and Radio-activity. J. M. Benade. Proc. Fifteenth Indian Sci. Cong., 1928, p. 140.

Tests showed that the rate of discharge of an electrometer, due to the presence of radioactive material in an ionization chamber, was unaffected by variations in the intensity of cosmic radiation. A self-recording electrometer was submerged in the Dal Lake in Kashmir.

CHEMICAL ABSTRACTS.

Quantitative Chemical Analysis by Means of the Absorption of X-rays. N. H. Moxnes. Ztschr. physik. Chem., 1931, CLII, Abt. A, 380-408 (*cf.* Chem. Abs., XXIV, 548).

An analytical method based on the absorption of X-ray line spectra was developed. A photographic-photometric method for measuring the intensity of X-rays was described. When it was applied to the *analysis of Zn* in ZnO and *Ni* in NiO, the maximum errors were 10 and 39 per cent, respectively.

CHEMICAL ABSTRACTS.

Sun Rays and Vitamin D. A. van Wyk, E. H. Reerink, and W. Mörikofer. Strahlentherapie, 1930, XXXIX, 80-92.

The authors compared the action of rays from the sun and those from a Hg quartz lamp upon ergosterol solution in hexane and found two essential differences: the radiation of the ergosterol solution in the sun rays caused a quicker destruction of the formed Vitamin D and also the formation of another decomposition product of unknown composition. The different distributions of the intensities of the radiation of the two sources of light are believed to be the explanation for the differences. They found that the relation for vitamin destruction and vitamin formation is three times as large with the sun rays as with the Hg quartz lamp. Therefore, with sun radiation much quicker decomposition of Vitamin D will take place, so that only a small portion of ergosterol is transformed into Vitamin D, while a considerable portion of the latter is decomposed.

CHEMICAL ABSTRACTS.

Experimental Electron Distributions in Atoms of Monatomic Gases. E. O. Wollan. Phys. Rev., July 1, 1931, XXXVIII, 15. (Reprinted by permission.)

The radial electron distribution in the atoms of helium, neon, and argon is calculated from the writer's recent data for the intensity of X-rays scattered by gases. These curves are found to be in good agreement with similar curves derived from wave mechanics. They represent the electron distribution for the atom in a state of rest and hence show more detail than similar curves calculated with the aid of crystal reflection data. In the case of neon, the experimental data are sufficiently complete to separate the K and L electrons. The smaller radius of these levels in argon makes such a resolution impossible for the wave length of the X-rays used. A comparison of the U curve for argon with the same curve for the chlorine ion from NaCl at 0°K shows the presence of zero point energy for the ion in the space lattice of the crystal.

II.—The X-ray Examination of Nitroramie. Frank D. Miles and James Craik. Jour. Phys. Chem., 1930, XXXIV, 2607-2620.

The X-ray diagrams of nitroramie containing up to 7.5 per cent N were identical with

the diagrams of cellulose, which is possibly due to inter-micellar nitration. A N content of from 7.5 to 10.3 per cent resulted in physical disintegration of the fibers and indefinite diffraction, but the parallel arrangement of the chains in the nitrated structure was thought to persist since the regenerated cellulose was of an ordered form. At 10.3 per cent N the stage of internal disorganization is passed; at 12.7 or 12.8 per cent N there is a discontinuity, and after this the comparatively definite trinitrate is reached.

CHEMICAL ABSTRACTS.

THE CHEST (DIAGNOSIS)

Tension Pneumothorax, with Subcutaneous Emphysema: The Mechanism of Tension Pneumothorax. Nathan M. Fenichel. Jour. Am. Med. Assn., July 4, 1931, XCVII, 20-23.

Two unusual instances of pneumothorax complicated by subcutaneous emphysema have been observed. In the first patient, generalized subcutaneous emphysema and a left pneumothorax followed an attempt at an intracardiac injection of epinephrine. In the second patient, these phenomena were observed after the aspiration of a pleural effusion.

It is generally held that a pneumothorax is produced by the aspiration of air from the ruptured lung into the intrapleural space during inspiration. While this explanation may account for the ordinary pneumothorax, in which the intrapleural pressure is negative or atmospheric during the inspiratory phase, it does not satisfactorily apply to a tension pneumothorax, in which the pressure is positive during both phases. A consideration of the complete mechanism involved in the latter type of pneumothorax is presented.

C. G. SUTHERLAND, M.D.

A Further Study of Massive Collapse of the Lung. H. C. Jacobaeus and N. Westermark. Acta Radiol., 1930, XI, 547-592.

The authors report an extensive continuation of their studies in massive collapse of the lung. In twenty-five cases of hemoptysis studied in the past three years, they noted lung collapse in four. Several cases of acute collapse occurred with bronchitis and three with bronchiectasis. Five cases of collapse were reported in cases of chronic pulmonary tuberculosis without hemoptysis and five cases of lung tumors with partial lobar collapse. They felt that the collapse had a definitely bad effect in their cases of chronic pulmonary tuberculosis. The unusual distribution and limitation of pleural exudates in the cases of lung tumors are thoroughly discussed.

M. J. GEYMAN, M.D.

THE CHEST (GENERAL)

Bilateral Spontaneous Pneumothorax. Clarence E. Bates. United States Vet. Bureau Med. Bull., June, 1931, VII, 602.

The author reports a case of bilateral spontaneous pneumothorax diagnosed by X-ray examination. Except for occasional attacks of pleurisy and the presence of fistula *in ano*, no history was obtained referable to tuberculosis. Dyspnea and lack of endurance were the chief symptoms presented by the patient. The prognosis is considered good in this case.

J. N. ANÉ, M.D.

The Azygos Lobe of the Lung. E. H. Shannon. Canadian Med. Assn. Jour., April, 1931, XXIV, 498-500.

In the course of routine radiographic examinations of the chest, extending over a period of several years, an abnormality in the right upper lobe was noted on two or three occasions, the nature of which was obscure. This abnormality took the form of a curved linear shadow running downward and somewhat outward from the apical region to a variable distance from the lateral aspects of the vertebræ, then passing in a smooth curvature mesially and downward to about the level of the

second costal cartilage. At the lower end the shadow expanded into an elongated and roughly triangular density, which varied in size from 0.5 to 3 millimeters. The abnormality was not associated with a deviation of the trachea, such as would probably have been present had the condition been due to a substernal thyroid, nor was the appearance that of a large persistent thymus gland.

Reference to the literature showed that others had observed the same condition and attributed it to an accessory lobe which they termed the "azygos lobe." It is produced by an anomalous position of the azygos major vein. In this position, the vein, instead of curving over the root of the lung, is displaced outward so that it may make a deep fissure in the upper part of the lung, marking off an extra lobe.

The reflection of the parietal pleura resulting from the aberrant course of the vein as it sweeps forward and downward through the lung is responsible for the fine crescentic shadow in the apical region, the pleura being visualized by reason of an antero-posterior projection which shows it, as it were, edge on. The expanded triangular lower end of the curved line is due to a cross-sectional view of the vena azygos at the point of confluence with the superior caval vein.

Four cases are presented and illustrated by reproductions of radiographs. The importance of the recognition of the anomaly lies in the avoidance of erroneous interpretations of its structure in terms of disease.

L. J. CARTER, M.D.

Non-tuberculous Spontaneous Pneumothorax: with Report of Cases. Ralph L. Fisher. Ann. Int. Med., May, 1931, IV, 1395-1405.

Spontaneous pneumothorax is comparatively rare in diseases other than tuberculosis. Pneumothorax is always secondary to lung or pleural lesions.

The X-ray findings are very important and show in general an enlargement of the hemithorax, with excessive clearness of the pulmonary field. The collapsed lung may be seen back against the spine, casting a gray shadow. The diaphragm is either lowered or flattened and practically immobilized.

There are two clinical types: the rapidly fatal (death occurring in a few hours), and the non-fatal, in which recovery may occur in from two to six weeks.

Three cases are reported in detail and illustrated by roentgenograms. In one case, asthma was the causative agent. In a second case, no cause was found. In the third case, physical exertion seemed to be the etiologic factor. Symptomatology, physical signs, and treatment are discussed.

The impression is gained that idiopathic spontaneous pneumothorax is of more frequent occurrence than is generally recognized.

CHARLES H. DEWITT, M.D.

Multiple Pulmonary Abscesses Simulating Tuberculosis, Caused by the Friedländer Bacillus. H. C. Sweany, Asya Stadnichenko, and Karl J. Henrichsen. Arch. Int. Med., April, 1931, XLVII, 565-582.

This case report is a critical discussion of multiple pulmonary abscesses caused by the Friedländer bacillus which were mistaken for tuberculosis. The literature is extensively quoted, and clinical and bacteriologic observations are carefully recorded, also including the autopsy findings.

The case may be summarized as one of chronic bronchopneumonia, with progressive necrosis and abscess formation, exhibiting a varied type of cell reaction from lymphocytes, monocytes, and plasma cells to focal abscesses of polymorphonuclears.

Fibroblasts and connective tissue appeared about and within the older lesions and the walls of the cavities became lined with metaplastic cuboidal or squamous epithelium. An important feature of the disease is the continuous succession of lesions, usually from the

apex to the base of the lung, each of which passes through the same evolution and changes from the acute to the chronic form.

The clinical aspects closely simulated chronic pulmonary tuberculosis, differing from it only in the general appearance of the patient, the irregularity in the temperature, and the obscure physical observations. The roentgen observations resemble those noted in chronic pulmonary tuberculosis. A bacteriologic examination should lead to a correct diagnosis.

H. A. JARRE, M.D.

THE CHEST (THERAPY)

Bilateral Empyema of the Pleural Cavities. E. Lawrence Keyes. Ann. Surg., May, 1931, XCIII, 1050-1063.

"Bilateral empyema of the pleural cavities," a condition in which pus is found in both pleural cavities at or about the same time, is usually considered a complication of unilateral empyema. It is almost always acute, very rarely chronic. The author has reviewed the literature and outlined the natural history and treatment of the disease in detail. The condition is probably more common than most text-books imply. Simultaneous bilateral thoracotomies are advisable under certain circumstances.

The author recommends that the second side be drained very soon after the first, and the initial drainage should be of the closed type. In all, forty-one cases of bilateral empyema occurring from 1910 to 1930, are summarized, and three cases previously unreported are related in detail.

F. B. MANDEVILLE, M.D.

Syphilis of the Aorta and Lung, with Atelectasis. H. E. Bank. United States Vet. Bureau Med. Bull., June, 1931, VII, 592-601.

The author reports the case of a colored patient, aged 35 years, who had contracted syphilis about twenty years before, for which he had, at no time prior to admission to the hospital, received antisyphilitic treatment. His symptoms at the time of admission were dyspnea, cough, expectoration, slight fever, loss of weight, pain in the chest and over the left kidney region, and occasional hematuria. Physical examination revealed absence of breath sounds over the left lower lobe. The Wassermann reaction proved positive. Roentgenograms at this time revealed scattered coarsely mottled areas, with slight pleural thickening in regions of the left lower lobe.

Potassium iodide to the physiological limit was administered and the patient's condition improved. Three weeks later a recurrence of symptoms, with pyrexia, occurred. It was noted at this time that roentgenograms revealed a displacement of the trachea, heart, and aorta to the left. The mottling previously seen had increased and extended to the upper lobe. Lateral films showed a definite enlargement in the hilum region. The symptoms subsided somewhat and the patient was given injections of neoarsphenamine and bismuth salicylate.

Roentgenograms made about one week later revealed almost the entire left lung field blotted out and presented a density equivalent to that of the heart shadow. Partial aëration of this lung was observed in the axillary region from the fourth to the ninth ribs. The heart and mediastinum were displaced to the left, and the right lung showed a marked compensatory emphysema. Heart measurements revealed a definite enlargement of the heart and aorta and at fluoroscopic examination a depression of the anterior wall of the esophagus by the mediastinal tumor mass was observed. This mass was of the aneurysm type and gradually increased in size.

Following intensive antisyphilitic treatment, subsequent roentgenograms made three months later revealed marked clearing of the left lung field, with much improvement in symptoms and physical signs. The aneurysm,

however, had undergone no change in size or shape.

J. N. ANÉ, M.D.

The Treatment of Empyema by Aspiration and Air Replacement without Drainage: Review of Thirty-five Cases. Joseph A. Danna. Jour. Am. Med. Assn., May 2, 1931, XCVI, 1453-1456.

Empyema is defined as the presence of pus in any portion of either pleural cavity. It is duced in any one of three different ways: First, though rarely, through the blood stream; second, directly through a wound; third, and most frequently, through the spread of an inflammatory or septic process from the lung or other adjacent structure. The result is either a local walled-off abscess or purulent infection of the entire pleural cavity. Whatever the method of treatment employed, no cure is possible until the source of infection or contamination of the cavity ceases to act as such. Experience has shown that the mortality was greatly reduced by deferring operation for several days after an effusion became purulent, giving time for inflammatory infiltration of the pleura and especially of the mediastinal pleura. The pleural cavity is rendered less elastic, thus diminishing the shock and respiratory and cardiac embarrassment following open drainage. The use of surgical solution of chlorinated soda for irrigation of the cavity shortened the period of hospitalization and hastened the period of closure.

A series of thirty-five cases is reviewed, in which the empyema cavity was emptied of pus, preferably done through a large needle. Gradually, as the pus was removed, air was injected, the volume being equal to that of the was injected, volume being equal to that of the pus removed. No drain was used, no form of suction, or irrigation. By physical examination and close study of the roentgenograms, the site and outline of the purulent effusion are determined.

The apparent advantages of the method are stressed and the various disadvantages of other methods are discussed in comparison.

CHARLES G. SUTHERLAND, M.D.

CONTRAST MEDIA

Researches in Radiologic Morphology of the Sphenoidal Sinuses by Contrast Media. Arrigo Foà and Pier Carlo Borsotti. Radiol. Medica, October, 1930, XVII, 1117-1126.

The authors have developed a method for the catheterization of the sphenoidal sinuses in order to inject opaque media therein. They have used Itard's catheter, slightly modified.

Nine cases showed normal conformation and it was possible to inject into the cavity "gelobarina," which, by delimiting the shape and dimension of the antrum, confirmed the characteristics of normality previously studied. A preliminary radiological examination left doubt concerning abnormal processes or congenital malformations in three cases and sinusography led, instead, to a diagnosis of inflammatory alteration. In the remaining cases, a total of 15, catheterization was practically or totally unsuccessful. The authors are of the opinion that, when possible, sinusography may show the following:

(*a*) The existence or lack of a sinusal cavity; (*b*) its shape and size; (*c*) its prolongations, if any; (*d*) topography of and relation between these prolongations and the ducts of the base.

L. MARINELLI.

Hepatosplenography: Radiologic Method of Examination of the Hepatic and Splenetic Parenchyma by Intravenous Injection of Thorotrast, a Colloidal Substance with a Thorium Dioxide Base. Silvije Kadrnka. Schweiz. med. Wchnschr., May 2, 1931, LXI, 425-428.

The author's method is based on the retention of colloidal substances by the reticuloendothelial system. Thorotrast is a 25 per cent colloidal suspension of thorium dioxide, being selected because of the high atomic weight of thorium, which is therefore radiopaque. After intravenous injection of this substance, one can determine not only the size of the liver and spleen, but also can derive some idea of their function.

Visualization of the liver by tetraiodophenolphthalein, first proposed by Einhorn, has proved impossible, due to the large dose of the dye necessary. Oka used tordiol to outline the spleen of animals. Similar attempts were made by Radt in animals. Oka's experiments with humans were unsuccessful, due to the undesirable secondary effects of the unstable solution.

Thorotrast is a stable solution containing 25 per cent thorium dioxide and 22 per cent metallic thorium by weight; it is not precipitated by the body fluids. A dose of from 0.8 to 1.0 gr. of thorotrast per kilo produces good visualization. It is given in small repeated doses, the first, from 0.1 to 0.15 gr. per kilo, the succeeding three to five injections being of larger amounts and given over a period of from six to eight days.

For intravenous injection, thorotrast is diluted nine times by volume with 5 to 10 per cent glucose solution. The sterilized solution, heated to body temperature, is injected slowly. Films are taken twenty-four hours after the last injection. Visualization can be demonstrated as late as three months after injection.

H. C. Ochsner, M.D.

Oral Cholecystography: Fundamentals of Technic and Interpretation. William H. Stewart and H. Earl Illick. Med. Jour. and Rec., May 6, 1931, CXXXIII, 421-423.

By cholecystography is meant the outlining or visualization of the gall bladder by the X-ray after having filled the former with opaque dye. A chemical substance is given to the patient by mouth, this being excreted by the liver in the form of bile, which is opaque to X-rays. The shadow of this bile inside the gall bladder gives an outline to the viscus. The test is a functional one and to be successful requires the utmost attention to the following details of the technic: As low a kilovoltage as will penetrate the patient; double intensifying screens; Potter-Bucky diaphragm; firm compression of the patient with a rubber bladder; education of the patient in holding the breath; films of uniform density and quality; suitable preparation; strict adherence by the patient to instructions; careful interpretation, and repetition of the test if necessary. These are some of the essentials to successful examination.

The first films are made twelve hours after ingestion of dye; the second examination, sixteen hours after; then a fatty meal is given and films made at intervals until the bladder empties, the final examination being thirty-six hours after the dye is given. This is concluded by barium meal examination of the stomach for adhesions, or organic lesion of the stomach or duodenum.

W. W. Watkins, M.D.

A Contribution to the Knowledge of the Lymphatic System of the Lung: An Anatomic-roentgenologic Study. Oskar Meller. Fortschr. a. d. Geb. d. Röntgenstr., January, 1931, XLIII, 66.

The author uses thoriumhydroxydhydrosol which, due to its colloidal characteristics, appears to be most desirable for such studies. No conclusions are drawn as yet in regard to the anatomic configuration of the lymphatic pulmonary system.

H. A. Jarre, M.D.

Pyelography with Emulsified Campiodol. J. W. Visher. Ann. Jour. Surg., June, 1931, XII, 427.

The use of emulsified campiodol for pyelo-ureterography is advocated by the author. He believes it to be superior in value to sodium bromide, neosilvol, or sodium iodide. Lipiodol, although non-irritating, fails to project the finer details of the calices, since it is not miscible with urine. Another objection to the employment of the latter is its difficulty of injection through a ureteral catheter. He accompanies his article with several illustrations.

Davis H. Pardoll, M.D.

DENTAL RADIOGRAPHY

The Roentgen Ray in Dental Practice. A. J. Rogers. United States Vet. Bureau Med. Bull., May, 1931, VII, 499.

The author considers the application of the roentgen ray in dental practice in studying individual teeth and in observing grosser lesions, such as fractures, cysts, and tumors.

In the examination of the alveolar bone, individual teeth, and peridental membrane, the small intra-oral films are used. In the author's opinion, roentgen-ray examination should be made before bridges and dentures are constructed and attached. In this manner, root fragments, impacted or unerupted teeth, or alveolar abnormalities will be discovered, if present. The larger films show to greater advantage the location of pathology and its relationship to surrounding structures, and are especially valuable in orthodontia.

The author discusses briefly the necessity of a standardized method of numbering teeth and mounting of the intra-oral films.

J. N. Ané, M.D.

DIAPHRAGMATIC HERNIA

Repair of Diaphragmatic Hernia with Fascia Lata. Robert M. Janes. Can. Med. Assn. Jour., March, 1931, XXIV, 421.

The author mentions that in a survey of the literature he has been unable to find any record of the use of living suture in the repair of diaphragmatic hernia.

He then outlines the history of a case in which he made the repair in this way. The patient, a male, 23 years of age, had been injured two years previously by falling 60 feet on to a board floor. He was unconscious for several days, and later suffered extreme respiratory difficulty. The X-ray examination, of which two films are reproduced, shows the stomach high in the left chest.

Preliminary to the surgical treatment, a temporary paralysis of the left diaphragm was produced by crushing the phrenic nerve in the neck. Six days later the patient was given ether intratracheally and placed on the operating table on his right side, with his head elevated. An incision was made along the seventh intercostal space from the spinous process of the vertebra to the anterior axillary line. The muscle was elevated and the seventh and eighth ribs divided close to adjacent spinous processes. The intercostal muscles were divided through the length of the incision, and a small puncture made in the parietal pleura, through which air was permitted to enter the chest slowly. The thoracic cavity was then opened widely by completing the incision in the pleura and retracting the ribs. The left lung was found to be completely collapsed against the mediastinum; the remaining space in the pleural cavity was occupied by the stomach, all of the jejunum, half of the ileum, the splenic flexure and part of the transverse colon, part of the great omentum, and the left lobe of the liver. The opening in the diaphragm was easily identified. All of the displaced abdominal contents were returned slowly into the abdomen. A wide strip of fascia lata was removed from the thigh and used to close the diaphragmatic hernia.

After two months, a barium series showed the viscera in normal position. Six weeks later the chest had returned to normal, with the exception of a high immobile diaphragm.

L. J. Carter, M.D.

Diaphragmatic Hernia. Alessandro Bianchini. Radiol. Medica, October, 1930, XVII, 1127-1149.

The author presents a very detailed radiologic and clinical study of this rare anomaly and describes a case personally observed.

L. Marinelli.

DIATHERMY

The Technic of Surgical Diathermy: Describing a New Electrode. Albert Eidinow. British Med. Jour., May 23, 1931, No. 3,672, pp. 892-894.

In surgical diathermy high frequency cur-

rents are employed in two ways: (1) for the destruction of tissue by coagulation, and (2) for direct excision, similar to excision by a surgical knife.

In coagulation the extent and depth are regulated by the following: (1) The intensity of the diathermy current; (2) the time the electrode is in contact with the tissues, and (3) the nature of the electrical conductivity of the tissues.

A current of relatively high amperage (from 1 to 20 amperes), low voltage and low frequency (under 1,000,000 cycles per second) is employed.

The depth of coagulation can be controlled by regulation of the intensity of the current, by the size of the active electrode, and by the length of time it is in contact with the tissues.

The cutting of tissues by means of the diathermy current involves a technic which is different from the methods of coagulation. A diathermy current of short wave length, low amperage (from 100 to 200 ma.), higher voltage (from 4,000 to 8,000), and a frequency of 3,000,000 oscillations per second is usually generated.

The author has devised a new cutting electrode which, it is claimed, can be used for accurate incision and dissection with the same safety as the surgeon's scalpel. This electrode consists of a molybdenum wire which projects 2 mm. beyond a quartz rod, which is about nine inches long and is tapered and bent at its end. A capillary hole is bored throughout its whole length, and the molybdenum wire is threaded through the fine hole and projects for from 1 to 2 millimeters. This can be regulated and adjusted by a clamping screw. The molybdenum wire is connected to some copper flex, which is covered by rubber tubing throughout its whole length, and is attached to the outer wall of the terminal half-inch of the quartz rod. In this way the electrode is completely and safely insulated and can be readily sterilized by boiling. Since fused quartz can withstand high temperature, rapid cooling, and is a good insulator, there is no danger that this electrode will crack or be damaged. The electrode can be used repeatedly, as it is rustless and is not softened or damaged by high temperature or oxidation. The length of the active end of this electrode is roughly 2 mm., and it is surrounded by the quartz capillary bored rod and, therefore, is well insulated.

Operation by the diathermy current produces a sterile and almost bloodless incision; the lymphatics are sealed off and the danger of dissemination of malignant cells or bacteria is diminished. The heat caused by the high frequency current counteracts the surgical shock following exposure of wide areas of tissue, which are quite warm after diathermy operations.

This method of operation is indicated and has been employed for the following:

(1) The excision of areas of disease of the tongue and palate.

(2) The excision of malignant disease of the breast.

(3) The excision of areas of necrosis and ulceration following malignant disease.

(4) Radium and X-ray necrosis and ulceration.

(5) The excision of tissue in vascular areas, in which it is difficult to control hemorrhage by other means (bladder and brain).

After diathermy operations, a solution of flavine in liquid paraffin applied once every day is a suitable dressing.

W. D. MACKENZIE, M.D.

Radical Treatment of Prolapsed Hemorrhoids by Diathermy. H. Bordier. Med. Herald, Phys. Ther., and Endocrine Survey, June, 1931, L, 229-232.

The author describes the electrocoagulation of hemorrhoids with an insulated forked electrode which prevents destruction of the mucosa. The method requires local anesthesia, and the patient usually remains ambulatory. A number of treatments are required in most instances.

WILLIS S. PECK, M.D.

THE EAR

Radiography in Ear Diseases. S. Baumgarten. Wisconsin Med. Jour., October, 1930, XXIX, 574.

In examination of the ear, positive findings are of greater value than negative findings. If there are clinical evidences of ear complications and a negative X-ray report, this report should not change the clinician's decision. On the other hand, the X-ray evidence of the need for operation should be heeded, even when the clinical evidences are lacking. Proper radiographic analysis of the temporal bone is of great diagnostic, prognostic, and pre-operative value. In acute middle ear infections a series of examinations at intervals of from ten to fourteen days should be made. It is necessary to have films of diseased and normal sides, and the best results are achieved through close co-operation between clinician and radiologist.

W. W. WATKINS, M.D.

THE ESOPHAGUS (DIAGNOSIS)

A Contribution on the Etiology and Radiologic Differential Diagnosis of Diverticula of the Esophagus. Bruno Bellucci. Archivio di Radiologia, March and April, 1931, VII, 230-243.

The author emphasizes the necessity of using a position during the examination which will assure filling of the pocket of the diverticulum. He agrees with the hypothesis of Krause that many diverticula are associated with organic disease of the spine, as a result of which the normal tonicity of the esophageal walls is lost, so that local dilatation takes place during the act of swallowing. The article concludes with an extensive bibliography.

E. T. LEDDY, M.D.

Esophageal Stricture. L. J. Bernard. United States Vet. Bureau Med. Bull., May, 1931, VII, 435-440.

Esophageal strictures may be either spasmodic or organic in type. Spasmodic stenosis may result from any disturbance in the normal reflex action which is responsible for the propulsion of the bolus of food. Such a disturbance may occur as a result of hurried gulping of large boluses of food. Esophageal diseases or pathologic conditions in other portions of the gastro-intestinal tract may produce spasm sufficient to cause obstruction. Stenosis may occur also as a result of a basic neurotic factor, associated with hysteria.

While many theories of the mechanism of cardiospasm have been advanced, the author considers that of Mosher a most rational explanation. Mosher believed that the expansion of the abdominal esophagus was limited whenever it was encased by the left lobe of the liver. This condition is characterized by the retention of a large quantity of food in a greatly dilated thoracic esophagus.

Esophageal obstruction may result from scar tissue formation, associated with infectious granulomas, or following the swallowing of caustic alkali. Foreign bodies may likewise cause cicatricial strictures. These strictures occur most commonly in the middle third of the esophagus. The most common varieties of malignant growth producing esophageal obstruction are squamous-celled epithelioma and adenocarcinoma. Carcinoma of the esophagus is more common in males, is nearly always a primary growth, and occurs more frequently in the middle third. A moderate dilatation is often seen above the stenosis. The symptoms observed are dysphagia, loss of weight, regurgitation of blood-streaked material, cough, and pain.

Fibroma, lipoma, and myoma may produce esophageal stenosis occasionally. Polypoid fibromas are usually found attached to the anterior wall behind the cricoid cartilage. Diagnosis can be made by X-ray examination.

Periesophageal disease, such as thyroid enlargement, lymphatic infiltration, and abnormalities of the thoracic vertebræ should be considered. The esophagoscope and X-ray are not entirely dependable, but when a displacement of the esophagus occurs, the chances are in favor of a compression stenosis.

In regard to the differential diagnosis, difficulty in swallowing solids is more common in organic strictures, while the swallowing of fluids is difficult in functional disorders. Syphilitic strictures are practically confined to

the upper portion of the esophagus, while stenoses caused by peptic ulcers are found at the cardia. Regurgitation of blood indicates the possibility of malignancy in the presence of dysphagia. Fluoroscopy and esophagoscopy are the deciding factors in these conditions.

In the treatment of esophageal strictures, gastrostomy should be performed early, if indicated. Direct and retrograde dilatations are used in non-malignant conditions. In the author's opinion, early extirpation in the malignant type offers the only hope for cure.

J. N. Ané, M.D.

The Normal Mechanism of Swallowing. A. E. Barclay. British Jour. Radiol., December, 1930, III, 534.

The author's findings have been worked out largely from screen observations, deductive evidence, and radiographic records made in the shortest intervals of time practicable without specially elaborate apparatus. However, he believes that efficient cinematographic radiography would contribute most detailed and accurate information concerning the complex mechanism of swallowing. Many observations have been made with thick boli of food, following which it was deduced that muscular constrictor action in the pharynx and gravity play only minor parts in the act of swallowing. The result is brought about rather by negative pressure within the pharynx, which, in turn, is effected by a combined action of raising the larynx, and the backward movement of the tongue, which, together, completely obliterate the pharyngeal space for a short fraction of a second. With the mouth, nose, and larynx closed, reopening of the pharyngeal space produces the negative pressure, which accounts for the surprisingly rapid passage of even thick boli from the back of the mouth down into the upper esophagus.

J. E. Habbe, M.D.

EXPERIMENTAL STUDIES

The Physiology of Arthroplasty. Willis C. Campbell. Jour. Bone and Joint Surg., April, 1931, XIII, 223-245.

Animal experiments have been of little value in this problem, probably because it is impossible to duplicate the active motion essential in the post-operative management of arthroplasty in man. However, four other means of approaching the subject are as follows: (1) Histologic study of ununited fractures with false motion; (2) examination of joints in which ankylosis has been caused by spontaneous immobilization; (3) biopsy and autopsy in cases in which surgical arthroplasty has been done, and (4) roentgenographic series.

In spite of considerable effort along these lines, the author feels that the fundamental question as to the rôle and fate of transplanted fascia remains unanswered. He believes that fascia transplants are essential to a successful operation but admits that spontaneous mobilization of an ankylosed joint sometimes occurs and, of course, in such instances Nature works without the aid of fascia.

He refers to the work of Baer, who finds that interposed chromicized pig bladder becomes encysted and absorbed as though it were a foreign body but, for some unknown reason, does not stimulate the production of foreign body giant cells.

All in all, the paper constitutes a question rather than an answer.

Paul C. Hodges, M.D.

Thoracic Aneurysm: Statistical Study of Seventy-one Cases. Shelton P. Sanford. Ann. Int. Med., May, 1931, IV, 1417-1423.

This study is based on seventy-one cases, with necropsy in thirty-two cases. All patients were colored. The youngest was 20 and the oldest 80 years of age. The period of greatest frequency of disability was 40 years. There were fifty-four men and seventeen women. Study of the admission diagnoses showed that thirty were correctly diagnosed, chest pain and dyspnea being the chief complaints.

The duration of symptoms in forty cases was from one day to seven years. In the majority of cases death followed the onset of

symptoms within three months. In thirty-five cases, a definite history of an initial lesion was found. The Wassermann reaction on the blood was positive in fifty cases.

Roentgenographic examination was made in sixty-one cases, with findings suggestive of aneurysm in forty-seven. In fourteen cases, there was no reason to suspect aneurysm from X-ray findings, small aneurysms within the pericardium not being shown by X-ray.

The chief causes of death were rupture, 42 per cent, and pressure upon trachea, causing suffocation, about 20 per cent.

CHARLES H. DEWITT, M.D.

FOREIGN BODIES

Crochet Needle in the Bladder, with Secondary Perforation. Joseph Schwartz. Jour. Urol., May, 1931, XXV, 515-518.

X-ray examination revealed the presence of a crochet needle in the bladder of a female fourteen years of age, which resisted transurethral extraction. After several unsuccessful attempts to remove it, the needle perforated the bladder wall. It was removed through a suprapubic midline incision from the abdominal cavity, following its localization by means of the X-ray.

DAVIS H. PARDOLL, M.D.

Foreign Bodies in the Eye. L. Webster Fox. Med. Times, July, 1930, LVIII, 191.

The X-ray is an indispensable aid in cases of metallic foreign bodies in the eyes. The use of the giant magnet before localization by the X-ray offers unnecessary violence to an already injured organ. The older technic called for an attempt to locate the foreign body immediately by the giant magnet. Any institution elaborate enough to possess a giant magnet will also possess a modern X-ray apparatus, and can make a localization in a very short time.

W. W. WATKINS, M.D.

GALL BLADDER (NORMAL AND PATHOLOGIC)

A Study of the Comparative Values of the Oral and Intravenous Methods of Gall-bladder Visualization. Harold E. Wright. Southern Med. Jour., May, 1931, XXIV, 375-378.

This study embraces a series of examinations by the oral method, with a re-examination by the intravenous method of all cases which failed to visualize by the oral route. Thirty cases are included. The technic for the oral method was to administer four and a half grams of the dye in plain capsules after supper of the day before examination. The first films were taken twenty-two hours following administration of the drug. Twenty-two cases failed to visualize by the oral method, and, of these, nineteen also failed to visualize by the intravenous route, giving an apparent superiority of the intravenous over the oral method of 10 per cent. The author, while preferring the intravenous technic, feels that errors can be reduced to as low as 5 per cent by repeating the oral administration. He also thinks that a larger series of cases would make us increasingly better satisfied with the oral method of gall-bladder visualization.

W. W. WATKINS, M.D.

GASTRO-INTESTINAL TRACT (DIAGNOSIS)

Diverticular Images of the Stomach. Alberto Anzilotti. Radiol. Medica, September, 1930, XVII, 1033-1048.

According to Anzilotti, there is no such thing as a functional diverticulum of the stomach but only diverticula of organic nature, either congenital or acquired. The essential signs of a diverticulum are as follows: (1) The paragastric image which fills up with the stomach and usually empties later; (2) the presence of an air bubble; (3) the transmis-

sion of contractions originating from the gastric walls to the contour of the diverticulum; (4) the existence of a canal of communication with the gastric cavity; (5) its location (cardiac or pre-pyloric region, greater curvature), which is very seldom the site of an ulcer; (6) displacement of the diverticular image with the gastric shadow as the patient changes his position.

As to the differential diagnosis between diverticulum and ulcer, the author notes that statistics do not yield any evidence of diverticula along the lesser curvature. Furthermore, ulcers present the characteristic niches and essential contours unaffected by peristaltic movements. An unquestionable differential diagnosis between diverticula of the gastric and duodenal regions may be made by trying to dissociate the diverticular image from the gastric shadow for different positions of the patient's body. The author insists upon the inadvisability of classifying as diverticula (pseudo or otherwise) some spastic phenomena of the stomach, as done by Brdiczka. He describes a clinical case of diverticulum situated on the greater curvature and explains in detail the different factors contributing to the diagnosis.

L. MARINELLI.

Significance and Evaluation of the Transverse Folds of the Canalis Egestorius as a Disease Symptom. Robert Sandera. Fortschr. a. d. Geb. d. Röntgenstr., January, 1931, XLIII, 53.

The author is of the opinion that inflammatory processes in the bursa omentalis, which might be produced by local or distant foci, are able to produce atypical mucosal folds, that is, transverse folds in the canalis egestorius. He reports several cases in which this coincidence was observed and verified autoptically. In the majority of his cases the symptom was coincident with gastro-duodenal ulcer. The opinion is stated, however, that, besides ulcer, pancreatitis, cholecystitis, appendicitis, and chronic mesenteric lymphadenitis might produce such symptoms.

Abstractor's Note.—We doubt that the observation recorded should be generalized broadly, as we are of the opinion that one may find transverse mucosal folds in the canalis in entirely normal stomachs.

H. A. JARRE, M.D.

Intestinal Obstruction from Eating Bran. Murray B. Davis. Jour. Am. Med. Assn., July 4, 1931, XCVII, 24.

This is a case report of a complete obstruction about 30 cm. from the ileocecal valve, in the ileum, from a mass of bran about the size of a hen's egg. The patient had suffered for years from constipation and had started to eat bran about a week before the date of the obstruction.

One other case, reported by Alvarez, was all he could find noted in the literature.

C. G. SUTHERLAND, M.D.

Radiographic Methods for Exact Diagnosis of Affections of the Large Intestine. G. Bertel. Archivio di Radiologia, March and April, 1931, VII, 297-334.

The author emphasizes the necessity of careful preparation of the intestine before examination and scrupulous attention to details during radioscopy, so that diagnosis of lesions intrinsic and extrinsic to the large intestine may be facilitated. He illustrates many points of his technic and gives many practical hints for carrying it out.

E. T. LEDDY, M.D.

The Roentgenologic Demonstration of Varices in the Duodenal Bulb. W. Alberti. Fortschr. a. d. Geb. d. Röntgenstr., January, 1931, XLIII, 60.

The author describes the characteristic appearance of varicosities in the duodenal bulb. They produce a peculiar spotted appearance of the bulb, especially when it is slightly compressed, this being the result of a certain ir-

regularity of the mucosal surface, resulting from diminution of the lumen by ectatic veins, and may be recognized during fluoroscopy. Furthermore, one then may find rounded, marginal, small, filling deficiencies (which, however, may also be simulated by normal mucosal folds), horse-shoe and ring-shaped surface deficiencies, and finally lobulated and clover-leaf-shaped defects produced by the ectatic blood vessels.

Abstractor's Note.—The author errs when he assumes that the demonstration is original. We remember having seen such demonstrations by Dr. Lewis Gregory Cole.

H. A. JARRE, M.D.

Diverticulum of the Esophagus. Harry E. Bundy. United States Vet. Bureau Med. Bull., May, 1931, VII, 441-444.

Diverticula of the esophagus occur most frequently after the fourth decade and may be either single or multiple. They may be divided into traction or pulsion varieties.

Traction diverticula are practically always found in the mid-thoracic region and result usually from inflamed lymph glands, pleurisy, calcicosis, mediastinitis, and pericarditis. These sacculations may be only a simple outpouching of all the esophageal coats without food retention, or the sac may be pulled upward, with the orifice at its lowest point. These types are difficult to diagnosticate even with the use of the X-ray, unless the patient is placed in the Trendelenburg position. Traction diverticula may be without symptoms and may go unrecognized, unless seen during a routine examination of the gastro-intestinal tract. Dysphagia, regurgitation, and loss of weight are noticed by those patients with sacculations which contain food. This class of diverticula is treated by dilatation, while the pulsion type is generally a surgical problem.

Pulsion diverticula are usually located posteriorly at the junction of the esophagus and pharynx. An increase in intrapharyngeal pressure at this point of greatest weakness of the wall is responsible for the resulting outpouching of the mucosa and submucosa, which often points to the left side.

The author reports a case of an esophageal diverticulum which was diagnosed by means of the X-ray and treated surgically, using the two-stage operation devised by C. H. Mayo.

J. N. ANÉ, M.D.

Extra-bowel Pathology. P. F. Butler and Max Ritvo. Am. Jour. Roentgenol. and Rad. Ther., April, 1931, XXV, 474-481.

Tumors of the abdomen and pelvis, not arising from the gastro-intestinal tract, are not uncommon. Such masses are often difficult to diagnose exactly by ordinary clinical methods. Often the displacements or deformities shown by gastro-intestinal X-ray study help to make an accurate pre-operative diagnosis. In contrast to pneumoperitoneum and other of the more elaborate radiologic procedures, the barium meal and enema examination are usually simple, painless, and easy to perform.

The routine technic consists of plain films of the abdomen, following which the usual barium meal is given and studies are made, immediately and at three, six, twelve, and twenty-four hours, occasionally also at two, four, and forty-eight hours, and the enema examination of the colon may also be made.

The writers divide the abdomen into left upper quadrant, right upper quadrant, epigastrium and hypochondrium, and lower abdomen and pelvis. The various possibilities for tumor formation, either inflammatory or malignant, in each of these regions are considered and the points of differentiation, insofar as the gastro-intestinal study affords, are given.

Illustrations of tumors arising in the left upper quadrant in the nature of hypernephroma, splenic tumor, and tumors of the lesser peritoneal cavity are shown. Tumors of the gall bladder and liver enlargement are presented, with the resulting gastro-intestinal deformities and displacements to illustrate right upper quadrant masses. For tumors in the epigastrium and hypochondrium, cases of carcinoma of the head of the pancreas of the transverse colon, and cyst of the small bowel are shown. In the lower abdomen and pelvis,

the possibilities of showing more or less characteristic displacements are illustrated by a case of appendiceal abscess, one of pregnancy in the second trimester, and another of diffuse carcinoma of the pelvis.

The authors emphasize that not infrequently one or more signs of displacement or deformity may be present on routine gastro-intestinal study but the correct diagnosis is not suspected, because the sign is overlooked.

J. E. HABBE, M.D.

About Obscure Hernias and the Insufficiency of the Esophageal Hiatus. Hans Heinrich Berg. Röntgenpraxis, May 15, 1931, III, 443-455.

During the course of the examination of the relief of the gastric mucosa, the author found that a differentiation between the mucosa of the esophagus and the stomach is almost always possible with his method. The fixation of the digestive tube in the region of its course through the diaphragm is relatively loose. Very often one may observe parts of the gastric mucosa above the ring of hiatus; this should not be called a herniation, but only an insufficiency of the hiatus esophageus. The roentgenologic demonstration is possible only in the horizontal position, and examination should be made with the head in a lower position than the pelvis. Herniation through the hiatus and hiatus insufficiency are predominantly seen in the later years. Besides congenital anomalies, the factors due to increasing age apparently are mainly responsible for them. The author's own material consists of 22 hiatus hernias and about the same number of insufficiencies. The small degrees are not counted in this number.

The patients are mostly of the pycnic type and very often fat. Occasionally they have other hernias or diverticula. A typical clinical symptom cannot be elicited. In about one-third of the cases, some difficulty in swallowing is complained of, and sometimes indefinite symptoms of indigestion (like ulcer or gall-bladder disease) are evident. Roentgenologic examination is often the only means of demonstrating these lesions. Examination with the patient standing upright is only very rarely successful. Occasionally one may see a part of the *Magenblase* behind the heart on a flat film. Examination of the patient in a horizontal position and occasionally manual pressure over the left hypochondric region show the obscure herniations and relaxations of the esophageal hiatus. A certain amount of dilatation of the esophagus is usually seen in definite herniation.

The variable complaints, the above described habitus, the age of the patient, and the presence of other hernias should make one think of diaphragmatic hernia, and a roentgenologic examination with this possibility in view should be done. The pathologists have not found it as frequently as the roentgenologists, which might best be explained by the autopsy technic as used at present. A conservative therapy is indicated in the largest number of such cases; exceptions are only acute incarceration and complications by neoplasm or ulcer.

H. W. HEFKE, M.D.

Pedunculated Polyp of the Stomach. W. Natorp. Röntgenpraxis, May 15, 1931, III, 456-460.

A benign polyp with a long pedicle was found roentgenologically in a woman 41 years of age. The symptoms were markedly dependent on the position of the patient, bedrest relieving all symptoms. Gastric polyps can cause considerable pain over many years and may induce hyperperistalsis. Roentgenologically, the polyp could be demonstrated, as well as its long pedicle, by a small amount of a barium mixture plus air inflation. Histologically the tumor removed by surgery was an adenoma.

H. W. HEFKE, M.D.

Roentgen Relief of the Gastric Mucosa. Otto Dyes. Fortschr. a. d. Geb. d. Röntgenstr., January, 1931, XLIII, 1.

The roentgen relief of the gastric mucosa, in other words, the detailed appearance of gastric rugal structure, is not merely the effect of the elasticity of the gastric walls influenced and modified by the contents it surrounds and

adjacent organs. Neither is it exclusively altered by the state of contraction of the muscle coat; it is rather dependent on the function of the muscularis mucosæ and the state of hydration—turgor—of the mucosa itself. On the other hand, the muscularis mucosæ in different parts of the stomach is variable in function, as proven by the effect of pharmaca, which may cause contraction of fibers from the region of the cardia and relaxation of fibers from the canalis or *vice versa.* Thus it is to be assumed that the formation of rugæ is produced by the muscularis mucosæ. This muscle layer, however, is not capable of producing unconditional changes in the course and type of these folds. Of course, there also must be a co-ordination of function of all structures participating in the formation of the gastric wall.

Detailed study of gastric rugal structure is important and leads to many diagnostic conclusions which cannot be gained from the observation of complete filling and contour study alone.

Systematic demonstration of the mucosal structure depends upon methodical success in obtaining a thin layer of contrast medium between the gastric walls. This may be done by either one of two methods: (1) By complete filling, carefully determined localized pressure, and an aimed snap-shot exposure; (2) by ingestion of small amounts of entirely homogeneous and liquid contrast medium which, by flowing along the mucosal folds, will be entirely sufficient, without any manipulation or pressure, to satisfactorily outline all the folds. They are thus rendered available for roentgenographic survey and fluoroscopic study, as well as for localized aimed exposure. The latter method appears preferable as it is a more physiologic procedure.

A detailed analysis is then given of the rugal structure of the normal stomach, with a description of variations as they occur under the influence of posture, peristalsis, distention, pressure, etc. (The latter factor is of particular importance, as the one method mentioned above is dependent upon the production of pressure for the visualization of gastric folds, and the results thus obtained are not readily compared with the ones described in this paper.) The effect of extra-gastric pathology is demonstrated on two cases. The possibilities of the study of rugal structure are illustrated by the detection and description of a small disc-shaped carcinoma at the junction of the fundus and corpus, which entirely escaped observation on a filled stomach. The image of chronic gastritis in the active stage and also following clinical improvement is characterized by swelling of the mucosal folds. This may be interpreted as an expression of hypertension or of hyperplastic hypertrophic processes which are also observed in portions of the mucosa temporarily in a vicarious state of increased function. The latter factor is very annoying and complicating in the differential diagnosis of gastric disease. It is, therefore, necessary to also observe additional factors, for instance, rigidity of folds, definition of borders, irregular course, granulation, and irregular sedimentation, when an attempt is made to furnish a reliable diagnosis of gastritis.

It is important to have the entire inner gastric surface come in contact with the contrast medium as otherwise diseased areas might easily escape observation.

Recent experimentations by Regelsberger, published in *Röntgenpraxis,* II, 19, utilized colloidal-thorium-dioxide as contrast medium, which apparently forms a tenacious precipitate on the mucosa when its positively charged particles come in contact with the negatively charged mucosal surface.

This paper is very instructive and worth while reading in the original. We also refer to the index of literature and to a book by H. H. Berg, "Röntgenuntersuchungen am Innenrelief des Verdauungskanals," published by Georg Thieme, Leipzig, 1930.

H. A. JARRE, M.D.

Diverticula of the Duodenum. S. Gilbert Scott. British Med. Jour., Feb. 28, 1931, No. 3660, p. 346.

Diverticula of the duodenum deserve more careful consideration and investigation than have hitherto been given them. As a rule, the changes are only catarrhal, but in some cases

suppuration, ulceration, and even perforation are met with.

The causes of symptoms are direct and reflex. A reflex resulting in spasm of the pylorus or forcible peristalsis of the duodenum may lead to definite attacks of pain and vomiting, often called "bilious attacks," and starting in childhood.

Most of the diverticula examined by the author retained their contents for a brief period after the meal was clear of the stomach, suggesting atrophy or atony of the muscle-coat from over-distention. The etiology of this process is discussed.

Most duodenal diverticula are well developed by the time the patient is forced to seek medical advice. Many are missed in their early stages, however, owing to the fact that most workers depend primarily on X-ray films for their diagnosis, for, although the pouch itself may be large, the opening into it may be small, and unless the contents of the duodenum are dammed up and manipulated into the pouch, with the hands on the abdomen, little or none of the meal may enter.

It is stressed that a clinical diagnosis is practically impossible, as the symptoms are so varied and at times resemble so closely those of other pathologic lesions. A typical case history is given, stressing the importance of a history of bilious attacks in childhood, which are never entirely outgrown. Once it has been established that a diverticulum is primarily responsible for symptoms, surgical measures will eventually become necessary.

W. D. MACKENZIE, M.D.

GENITO-URINARY TRACT (DIAGNOSIS)

The Pyelographic Diagnosis of Renal Tumors by Retrograde Pyelography. Tito Lucri. Urol. and Cutan. Rev., May, 1931, XXXV, 308-312.

When repeated pyelographic examinations reveal typical deformities of the renal pelvis or calices, even if the clinical symptoms do not allow a diagnosis of renal neoplasm with assurance, the author believes that it is possible to make the diagnosis with almost mathematical certainty from the pyelographic data alone. The diagnosis becomes even more certain when the pyelographic findings and the clinical symptoms agree exactly.

The author reports two cases of renal tumors in which diagnoses were made by retrograde pyelography and confirmed by operative findings. The first case was that of a female, 27 years of age, who complained of hematuria. Pyelographic examination revealed a marked filling defect in the right renal pelvis. At operation, a neoplasm with the appearance of a hypernephroma was discovered. The second case was that of a male, 72 years of age, with symptoms of dysuria, hematuria, and pain. A simple roentgenogram of the left renal region showed the presence of small calcareous deposits throughout the renal substance. In addition to these findings, amputation of the superior calyx, with dilatation of the renal pelvis, was observed on pyelograms. Surgical intervention confirmed the pre-operative diagnosis of calcareous pyonephrosis.

While there is some controversy among urologists regarding the value of pyelography in the early diagnosis of renal neoplasms, some of the American authors further believe that by pyelography a differentiation between carcinoma and hypernephroma may be made. They consider the pyelographic findings typical of hypernephroma to be an elongation and narrowing of the pelvis and calices, the deformity having the appearance of a dragon's claw, while in carcinoma they show shadows and filling defects of the pelvis and amputation of one or more calices.

The author believes that more precise and neater roentgenograms are obtainable by retrograde pyelography than by intravenous urography, even though the most rigid technic be followed in the latter.

J. N. ANÉ, M.D.

Primary Carcinoma of the Ureter with Atrophic Hydronephrosis. Luigi Caporale.

Urol. and Cutan. Rev., June, 1931, XXXV, 341-344.

The author reports a case of primary carcinoma of the ureter with atrophic hydronephrosis, which he observed in the Surgical Clinic of Turin, Italy. Only fifty-one cases of this condition had been previously reported in the literature.

The patient, a female, 75 years of age, entered the clinic complaining of intermittent hematuria, lasting from three to four days at a time. This condition began two months previously and was associated with a vesical tenesmus and burning. Pain in the left flank radiating to the ureter was also experienced by the patient. The physical examination was essentially negative, except for slight pains on palpation over the left ureter. The examination of the urine showed traces of albumin with numerous red and white cells in the sediment. Roentgenograms made of the renal regions were negative for calculi. Cystoscopy revealed in the region of the left ureteral orifice a polypous vegetation, reddish in color, which bled easily. The growth was noted to protrude into the bladder upon each urinary ejection and to re-enter the ureter in the intervals between ejections. Indigocarmine solution appeared on the right side after five minutes, but none was in evidence on the left side after twenty minutes.

The ureteral catheter was easily introduced into the left ureteral orifice, but it was arrested at a distance of 7 cm. from the meatus, and further progress was found impossible. An opaque fluid introduced through the left ureteral catheter failed to pass the obstruction but was seen to flow back into the bladder. One hundred c.c. of uroselectan were next administered intravenously. No reaction was manifested by the patient. Pyelograms showed a small, clearly visible left renal shadow, but the left pelvis and ureter were not visualized, the right renal pelvis appearing somewhat dilated.

With the operative cystoscope, a fragment of the papillomatous growth situated in the ureteral orifice was removed and was diagnosed microscopically as a papilloma of the ureter. Following electrocoagulation of the mass, the urine cleared up and remained clear for a period of twenty days, after which it again showed evidence of blood. At operation, the left kidney appeared normal in size, and the left renal pelvis and ureter were found dilated and filled with urine. At a point from 7 to 8 cm. from the mouth of the bladder, the ureter showed a growth the size of a walnut, of hard elastic consistency, which was easily freed from its surrounding tissue. Microscopic examination of the growth revealed a primary carcinoma of the ureter. Following the operation, the patient's condition improved rapidly.

In a discussion of this condition, the author considers that the most common symptoms observed are: Pain in the affected side; hematuria; dysuria; anorexia; emaciation, and vomiting. In the majority of cases it produces dilatation of the cavity above, with consequent increase in the size of the kidney. While the diagnosis is not easy, cystoscopy, ureteral catheterization, retrograde and intravenous pyelography are valuable aids.

The treatment of choice is nephro-ureterectomy, but the prognosis is not always favorable.

J. N. Ané, M.D.

Symptoms and Diagnosis of Stones in the Urinary Tract. Robert F. Mathews. Urol. and Cutan. Rev., May, 1931, XXXV, 281-284.

The combination of X-ray and cystoscopy offers about 100 per cent efficiency in the diagnosis of urinary lithiasis. This combination includes pyelography, urography, and the confirmatory evidence of scratches on the wax-tipped catheter.

Pain so severe as to precipitate a renal colic is typical of a small stone and is due to obstruction to the outflow of urine. Large stones situated in the pelvis and calices produce neither gross hematuria nor pain, and the condition may not be found until the kidney is fully destroyed and the patient comes to autopsy. An acute retention caused by a stone plugging the male urethra may cause the patient considerable pain. However, at times pain in the

region of the right ureter, accompanied by a small amount of blood and pus, may not mean disease of the urinary tract but may signify an acute appendix.

The author believes that the diagnosis of stone in the urinary tract rests primarily with the roentgenologist, who is aided by various cystoscopic procedures. A stone in the lower ureter will cause a scratch on the wax-tipped catheter. In some doubtful cases, with the opaque catheter in the ureter, a double exposure, secured by shifting the X-ray tube between exposures, will confirm the diagnosis. A shadow in the region of the kidneys or upper ureter may be further studied by the X-ray catheter and a subsequent pyelogram.

"Uric acid" stones have about the same density as water and cast no shadow on the plain roentgenogram. On the pyelogram, however, a central dark area surrounded by the density of the opaque medium will make a diagnosis of stone.

The treatment of this condition is based on the size, shape, number, and location of the calculi. From 80 to 90 per cent of stones in the ureter pass. The other 10 per cent are removed either by cystoscopic manipulation or by open operation through the side. The author stresses the importance of conservatism in renal lithiasis, as stones are often bilateral and recurrent.

J. N. Ané, M.D.

Death after Intravenous Pyelography. Mario Santoro. Archivio di Radiologia, March and April, 1931, VII, 244-253.

The author reports a fatality in a lad, 15 years of age, in excellent general condition, who was examined directly because of hematuria and left renal colic and then with 40 c.c. 40 per cent uroselectan given by the usual technic. Uremia, coma, and death followed on the sixth day. Autopsy showed bilateral hydronephrosis, suppurative chronic nephritis, and bilateral pelvolithiasis. The author believes that uroselectan overloaded the already damaged kidneys and advises that all complementary examinations be carried out to determine kidney function before intravenous pyelography is done.

E. T. Leddy, M.D.

GENITO-URINARY TRACT (THERAPY)

Necrosis of Ureter, Following Repeated Injections of Mercurochrome and Silver Nitrate Solutions. Thomas N. Hepburn. Ann. Surg., May, 1931, XCIII, 1114.

A young man was taken sick with dysuria and frequency and was running the temperature of an acute pyelitis. The report after cystoscopy was pyelitis with cystitis. A bilateral ureteropyelogram, using 12 per cent sodium iodide, demonstrated a normally smooth right ureteral wall. The right kidney was sterile and functioning normally at this time. The temperature dropped to normal for five days and the condition then promptly recurred. The patient was cystoscoped and catheters were left up both ureters. There was pus from both kidneys. The catheters were left in position in the ureters for fifteen days, and each day the catheters were washed out with sterile water and 2 c.c. of 1 per cent mercurochrome, and 3 c.c. of 1 or 2 per cent silver nitrate were injected into them. After eight weeks, during which time the patient failed to improve, cystoscopy and ureteropyelogram demonstrated a dilated, ragged, right ureteral outline. The examinations were repeatedly negative for tuberculosis. Following a right pyelotomy, sodium iodide could not be made to go down the right ureter. Two months later, an operation disclosed no ureter below the pelvis.

The author believes that most probably some mechanical condition on the right side, which prevented the outflow of the mercurochrome and silver nitrate after it was injected, was sufficient to cause destruction of the right ureter. The roentgenograms are included.

F. B. Mandeville, M.D.

GRENZ RAYS

The Determination of the Half Value Layer of Grenz Rays. O. Gfrörer and

Heinz Berger. Strahlentherapie, 1931, XL, 590-598.

The discrepancies in the reports of various clinics concerning the results of Grenz-ray therapy may be partly due to differences in the tube potential, *i.e.*, the quality of radiation used. In order to facilitate a correct determination of the quality factor, the authors describe in this paper a method which permits, quite easily, the measurements of the half value layer of Grenz rays. They designed a little apparatus which can be attached to a number of ionization instruments. They demand that both apparatus and tubes should be so constructed and calibrated by the manufacturers that an accurate comparison of the potential would be possible. The thickness of the Lindemann window of the tubes must also be uniform so as not to influence quality and quantity of radiation. The authors state that one manufacturer is now making tubes which fulfill these requirements.

ERNST A. POHLE, M.D., Ph.D.

GYNECOLOGY AND OBSTETRICS

The Aschheim-Zondek Reaction in Hydatidiform Mole and Malignant Chorionepithelioma. H. C. Mack and A. E. Catherwood. Am. Jour. Obst. and Gynec., November, 1930, XX, 670-678.

Positive Aschheim-Zondek reactions have been obtained in cases of hydatidiform moles and malignant chorionepitheliomas have been demonstrated by Roessler, Zondek, Otto, Fels, and Schultze-Rhonhof, as well as the above authors. Mack and Catherwood report two cases of chorionepithelioma in which a positive Aschheim-Zondek reaction was obtained. One of these showed repeated negative reactions following hysterectomy, X-ray therapy, and colloidal lead therapy, and the apparent health of the patient has corroborated the conclusions drawn from the test that the disease had been cured. In the other case the persistence of a strong positive reaction (after the same treatment) antedated the development of two small metastases in the vagina two months after operation.

This test will probably prove of value to radiologists in their treatment of chorionepitheliomas, enabling them to know when all of the tumor tissue has been destroyed.

JACOB H. VASTINE, M.D.

About the Radiation Therapy of Uterine Myomas. Heinrich Martius. Med. Klin., May 15, 1931, XXVII, 719-722.

Radiation therapy must be considered as the treatment for myomas, surgery being resorted to only in cases in which irradiation is contra-indicated. The principal reason for the preference being given to irradiation is the absence of mortality, which is still around 3 per cent in very large surgical statistics. The intra-uterine radium application has also a considerable mortality, and roentgenotherapy is for that reason the treatment of choice. Older women with hypermenorrhagias are always treated by the roentgen rays, as well as all younger patients in whom an operation is contra-indicated for some reason.

Heart disease, extensive varicosities, arteriosclerotic changes, lung and kidney diseases, diabetes, toxic goiters, etc., are contra-indications against surgery. These contra-indications are applied freely, but if a patient is in good general condition, surgery should be considered as the best means of treatment. The chances of a rapid and complete recovery appear to be better after an operation than after irradiation. The statement, found frequently in the literature, that one should irradiate in patients forty years or above and operate in patients below forty is only an arbitrary one. If children are desired, enucleation of myomas in younger women, not irradiation, is indicated. The menopausal symptoms are much more marked after irradiation than after hysterectomy, with conservation of one or both ovaries. This fact must be considered a disadvantage of castration by roentgen rays, but not so important that one would not advise roentgenotherapy even in younger individuals, if surgery is contra-indicated.

From 1926 to 1929, 217 cases of myomas were seen in the Universitäts Frauenklinik

Göttingen; 42.5 per cent of them were treated by irradiation, 57.5 per cent were operated upon. Only such women were treated as had symptoms from the myomas. Submucous myomas, cases with marked pressure symptoms, and dangerous hemorrhages must be treated surgically. But even in submucous myomas, when surgery cannot be resorted to, irradiation may give good results.

H. W. HEFKE, M.D.

HEART AND VASCULAR SYSTEM (DIAGNOSIS)

Study of the Esophagus in Diseases of the Heart and Aorta. Nicola Lovisatti. Archivio di Radiologia, March and April, 1931, VII, 262-273.

The author shows the value of barium examination of the esophagus in studying the outline of the posterior border of the heart. Especially is this true in mitral disease and in cases of dilatation, tortuosity and aneurysms of the aorta, all of which cause displacement or deformity of the esophagus.

E. T. LEDDY, M.D.

Configuration of the Heart in Cardiac Disease. Arthur L. Smith. Nebraska St. Med. Jour., September, 1930, XV, 337.

No one can make a diagnosis of heart disease by the use of the X-ray alone, though the X-ray examinations have supplied us with many invaluable facts. The principal advantage of radiography is the making of permanent records of the size, shape, and position of the heart and its large vessels, while fluoroscopy is valuable in watching the movements of those organs. Combined fluoroscopy and orthodiagraphy are the most valuable. The size, shape, and position of the heart varies, as does the body of the patient; the size of the heart ordinarily varies directly with the size of the body, but this is not always true. Many elaborate measurements have been devised, but in the usual case the more simplified method is all that is necessary. In left ventricular hypertrophy, the increase in size is to the left and the apex is rounded, best seen in the left anterior oblique position; a typical example is seen in arterial hypertension. In mitral configuration, the left border bulges in the region of the left auricle, and the right auricle is pushed more to the right. The aortic configuration is an enlargement of the left ventricle and a widening of the aortic shadow. The article is illustrated by a number of very excellent drawings, showing the heart outlines in all types of heart disease.

W. W. WATKINS, M.D.

HEART AND VASCULAR SYSTEM (THERAPY)

Radiotherapy in the Treatment of Angina Pectoris. Bertrand and Labeau. Bull. et Mém. de la Soc. de Radiol. Méd. de France, March, 1931, XIX, 126.

After reviewing the literature and from their own conclusions, the authors believe there are definite indications for treatment in cases of angina pectoris. The choice of cases should be made and treatment given only in those not presenting lesions of the valves or cardiac insufficiency. Therapy is contra-indicated also in extreme old age.

The treatment factors are as follows: 25 cm. spark gap, 7 mm. aluminum filter, 30 cm. focal skin distance, 40 ma.-min., 5 portals of entry (three anteriorly and two posteriorly), one field per treatment, every second day. This may be repeated, if necessary, in one and one-half months.

CHARLES S. CAPP, M.D.

Radiation Treatment of Diseases of the Heart. Leopold Freund. Strahlentherapie, 1930, XXXVI, 516.

This is a brief discussion of the literature dealing with the use of roentgen and ultraviolet rays in the treatment of heart diseases.

E. A. POHLE, M.D., PhD.

THE KIDNEY

Spontaneous Rupture of the Kidney: Report of a Case. Richard B. Hullsiek. Urol. and Cutan. Rev., June, 1931, XXXV, 347-350.

In reviewing the literature, one is impressed by the frequency of kidney injuries following apparently mild trauma. Küster attributes this to the hydraulic pressure acting through the full vessels and pelvis causing the kidney to rupture along lines radiating from the tubules toward the point of maximum impact of the lower ribs, the opposing resistance being supplied by the vertebral column.

From a review of the reported cases, it is believed that spontaneous rupture is more likely to occur in a diseased than in a normal kidney. Arteriosclerosis, nephritis, stone, hydronephrosis, tuberculosis, neoplasm, polycystic disease, and other renal diseases have been found antedating the rupture.

The three cardinal symptoms of spontaneous rupture are: pain, hemorrhage, and tumor. In addition, there may be shock, nausea, vomiting, and subnormal temperature followed by fever and an increase in the leukocytes.

The treatment should depend on the individual case. Where hematuria is the only symptom, the author advises expectant treatment, while nephrectomy should be performed for a destroyed kidney, and abdominal incision for peritoneal tears. Whenever possible, conservative surgery should be employed with suture, drainage, and débridement of the affected organ.

The author reports the case of a female, 49 years of age, who experienced a sudden severe pain in the left upper abdomen. Hematuria resulted, with the appearance of blood clots in the urine. There was no history of trauma. Physical examination revealed an overtired, unresponsive patient, with pulse of 96 and temperature of 99.5 degrees. Tenderness with some rigidity was observed over the left upper quadrant. Several days later a tender mass was palpated in the left renal region, which moved with respiration. Albumin, sugar, and red blood cells were found in the urine, and the blood showed an anemia with a leukocytosis. The blood chemistry was normal except the blood sugar, which was 274 milligrams. Cystoscopy showed an old blood clot in the bladder. An X-ray examination, made with the ureteral catheters *in situ*, revealed a tumor mass in the left upper abdomen. Both catheters were then injected with sodium iodide solution and another roentgenogram was made. This showed both renal pelves, with downward displacement of the left kidney and outward displacement of the upper pole, changing the long axis of the left pelvis to a medial direction. The escape of opaque media laterally from a middle calyx of the left renal pelvis into the parenchyma gave the impression of a cavity communicating with the middle calyx.

The diabetic condition was first controlled by diet and insulin, and a left nephrectomy was later performed. A diagnosis of organized hematoma was made after pathological examination of the removed organ.

J. N. Ané, M.D.

Polycystic Kidneys. D. J. Turnbull (for A. G. Maitland-Jones). Proc. Royal Soc. Med., March, 1931, XXIV, 570.

The author reports a case of polycystic kidneys in a child ten years of age. Uroselectan was employed and showed the calices of the right kidney to be splayed out more than normally. Also, the left kidney secreted far more of the uroselectan than the right. In the discussion which followed, the possibility of bilateral tumors of the suprarenal cortex was considered.

Davis H. Pardoll, M.D.

THE LIVER

Subphrenic Abscess. Henry P. Brown, Jr. Ann. Surg., May, 1931, XCIII, 1075-1081.

An analysis of a total of eighteen cases of subphrenic abscess is made by the author, in which nine were recognized by the X-ray be-

fore operation. The X-ray examination failed to demonstrate two cases, and in seven, for one reason or another, pre-operative X-ray examination was not made, the condition probably not being suspected. The author fails to mention whether or not fluoroscopy, with observation of the diaphragmatic domes, was included in the X-ray examination. In this series, a correct pre-operative clinical diagnosis was made in only seven instances; four times it was definitely wrong, and in seven, it was not made at all, thus giving a correct percentage of thirty-eight.

The author concludes that one should not hesitate to use an exploring needle, when circumstances warrant it, if a correct diagnosis cannot be made by other means (physical and X-ray examinations). The X-ray, while a great aid in establishing a diagnosis of subphrenic abscess, is by no means infallible.

F. B. MANDEVILLE, M.D.

MEASUREMENT OF RADIATION

Interaction of X-rays with Bound Electrons. Austin J. O'Leary. Phys. Rev., April 15, 1931, XXXVII, 873-883. (Reprinted by permission.)

I. Change of Wave Length of Scattered X-Rays.—A previous analysis of scattered X-rays in this laboratory by means of the double crystal spectrometer showed fine structure in both the unmodified and modified lines. These fine structure lines were interpreted as being due to absorption of an amount of energy equal to the binding energy of the electrons in the scattering substance. Since then, other experimenters have failed to observe this phenomenon in scattered X-rays. The earlier work has been repeated using measuring apparatus having greater stability and sensitivity but with experimental conditions for producing the scattered radiation as nearly as possible like those of the earlier experiments. No fine structure was found though a line of intensity greater than 10 per cent of molybdenum $K\alpha_1$ unmodified could have been detected.

II. Change of Wave Length without Scattering.—A change of wave length ascribed to this type of phenomenon without scattering has been reported by B. B. Ray and R. C. Majumdar. A number of experiments have been performed in an attempt to detect a change of wave length of this type due to partial absorption of molybdenum $K\alpha_1$ and copper $K\alpha_{1,2}$ characteristic rays in the K-level of carbon. No indication of a modified line was found though a line of smaller intensity than that of the lines reported could have been detected. Two possible sources, other than a change of wave length, are suggested which may give rise to lines of the type reported.

The Scattering of X-rays by Gases and Crystals. G. E. M. Jauncey. Phys. Rev., July 1, 1931, XXXVIII, 1. (Reprinted by permission.)

Recently A. H. Compton and Jauncey and Harvey have obtained theoretical formulas for the scattering of X-rays by gases and crystals, respectively. By means of these formulas f' values can be calculated. From measurements on the diffuse scattering by rocksalt, Jauncey and Harvey have calculated f' values for the average atom, or $(Na^+ + Cl^-)/2$, in rocksalt. Wollan has also recently obtained f' values for neon and argon. The f' values for the average of neon and argon, or $(Ne + A)/2$ are compared with those for $(Na^+ + Cl^-)/2$ and an excellent agreement is found. Also these two sets of experimental f' values are shown to be in excellent agreement with the quantum mechanics model of Waller and James, It is shown that the difference between f' and f, the true atomic structure factor, is not negligible, and that the error in assuming f to be given by f' may be as large as 20 or 30 per cent at large values of $(\sin \varphi/2)/\lambda$. Also, it is pointed out that only f, but not f', values may be used in the Fourier analysis method of unravelling crystal structure.

Temperature and Diffuse Scattering of X-rays from Crystals. Y. H. Woo. Phys. Rev., July 1, 1931, XXXVIII, 4. (Reprinted by permission.)

Since the discovery of the Compton effect, it has been evident that the old calculation by Debye of the diffuse scattering of X-rays by a crystal should be amended to take account of the modified radiation, which is generally presumed to be incoherent. Extending the idea suggested by the writer in his theory of X-ray scattering by gases, it is postulated that, in considering the scattering of X-rays by a crystal, only the coherent radiation from the different lattice units will interfere with each other, whereas the incoherent radiation will be simply added up. An expression for the intensity of the diffuse scattering is thence developed which consists of two parts, one taking care of the coherent scattering as originally worked out by Debye and the other accounting for the incoherent scattering. The mathematical formulation is based on the theoretical investigation by Raman and A. H. Compton on the scattering of X-rays by a dynamic atom. The theory is compared with the absolute measurements of the scattering from rocksalt reported by Jauncey and May and the agreement seems to be very close if the temperature factor is taken to be e^{-2M} as calculated by Debye and Waller. The comparison also seems to suggest the presence of the zero-point energy. These are in accord with the conclusions recently drawn by James, Waller and others from a study of the temperature effect on the intensity of the X-rays regularly reflected.

The theory, therefore, seems to account for the so-called excess scattering, for the small scattering in the region of 0° scattering angle, for the position of the maximum scattering as well as the shift of this position with the wave length of the primary X-rays, for the occurrence of the minimum scattering at about 100° instead of at 90°, and finally for the general departure of the scattering curve from that predicted by Thomson's theory. A comparison is also made with Jauncey's experiment on the variation of the scattering by rocksalt with temperature and the result indicates that, owing to the presence of the incoherent term, measurements of this type will not test the present theory. It is pointed out that, being developed for a single crystal in which the atoms are supposed to be arranged with perfect regularity, the theory will not hold for the scattering of X-rays by the so-called amorphous substances. In these substances, the arrangement of atoms evidently introduces a type of irregularity which results in diffusely scattered rays in addition to those due to the thermal agitation.

Thus, under certain conditions, only a negligible portion of the coherent intensity of the X-rays, diffusely scattered by an amorphous substance, is influenced by the temperature. This explains the experimental fact recently reported by Jauncey and Bauer that there is no effect of temperature on the ratio of modified to unmodified rays in the Compton effect. Theoretical predictions for the crystal sylvine are given, and absolute measurements performed with homogeneous X-rays should easily test these results.

The Anomalous Scattering of Alpha-rays. Morris Muskat. Phys. Rev., July 1, 1931, XXXVIII, 23. (Reprinted by permission.)

The well-known wave mechanical expression giving the scattering function, to a first approximation, as an integral over the potential field of the scattering system, is inverted so as to give the potential field as an integral over the observed intensity of scattering. This is applied to the problem of determining the potential field causing the anomaly in the α-ray scattering by Mg as observed by Rutherford and Chadwick and Bieler. This anomaly, defined as the difference between the observed scattered intensity and that predicted theoretically on the basis of a Coulomb potential field, is represented by an empirical analytic expression in two different ways.

It is shown that the potential fields for both representations as derived by the above-mentioned inversion are essentially the same, and their form depends almost entirely on the single fact that the curve for the anomaly shows a marked minimum. In magnitude, this potential field never exceeds 10 per cent that of the Coulomb potential. It oscillates in sign,

and falls off very rapidly as one recedes from the scattering atom. It is pointed out that the small numerical value and oscillatory character of this potential field is in marked contrast to the assumptions that have been made hitherto, most of which have been that the potential is of the form of $1/\rho^n, n \geqq 2$, ρ being the distance from the center of the nucleus. It is finally noted that if the derived potential field is given an electrostatic origin it is equivalent to a series of shells of alternating sign of charge with a spacing of the order of 1.5×10^{-13} centimeter. This is just the inference drawn by Rutherford and Chadwick as to a possible cause for the anomaly.

Observations on Measurements in Surface Radium Therapy. Mario Luigi Asti. Radiol. Medica, September, 1930, XVII, 1065-1083.

Due to the numerous factors necessary to the accurate statement of a dose, the present status of measurements in radium therapy is somewhat confused. The author is of the opinion that the Dominici unit (D) is the most practical at the present time, although it is not rigidly defined. He proposes to define it as follows: Dose received in ten hours by a spherical ionization chamber 1 c.c. in volume, having a wall of 1 mm. Al, the center of which is situated 26.2 mm. from the axis of a 10 mg. Ra tube. The Ra tube must be 16 mm. long internally and have a filtering wall (platinum or gold) equivalent to 2 mm. of platinum. The axis of the tube must be parallel to the direction along which the measurement of the tube-chamber distance is taken. The author suggests also the technic to be followed in determining surface dosage.

A brief study of depth dosage after the manner of Bruzau is included in this article, with special reference to the influence of the volume of the scattering medium.

The conclusions reached are that the intensity of radiation at a given distance from the source is the same (within 10 per cent) whether the ionization chamber is in air or surrounded, at 10 cm. depth, by a large scattering mass. Furthermore, the difference in surface doses, as measured in air or with scattering, is not enough to warrant any serious consideration.

L. MARINELLI.

Scattering of X-rays from Gases. E. O. Wollan. Phys. Rev., April 15, 1931, XXXVII, 862-872. (Reprinted by permission.)

Measurement of the intensity of scattering of X-rays by various gases has been made for scattering angles between 10° and 90°. Soller slits were used to get a well-defined scattering angle and matched filters of ZrO_2 and SrO were used to isolate the Kα lines of molybdenum. Intensity measurements have been made for hydrogen, helium, oxygen, neon, and argon. All the measurements were put on the same scale by comparison of the intensity of scattering from the various gases with the scattering from hydrogen at 90°. This is equivalent to putting the intensities on an absolute scale since the scattering from hydrogen at 90° can be calculated with considerable certainty. Values of the structure factors for neon and argon were calculated and comparison made with those determined from wave mechanics for similar atoms.

A New Electric Pyranometer for Measurement of the Sun and Sky Radiation. Fritz Albrecht. Strahlentherapie, 1931, XXXIX, 535.

This is a description of the solarimeter of Moll-Gorczinsky, which facilitates the measuring and registration of the diffuse sky radiation.

ERNST A. POHLE, M.D., Ph.D.

The Importance of the Aperture in Actinometers for Measuring Sun and Sky Radiation. F. Linke. Strahlentherapie, 1931, XXXIX, 351-357.

This is a technical discussion of the various types of actinometers and their shortcomings. Emphasis is placed on the influence of the opening diaphragm upon the measurements.

Before results obtained by the various observers and illustrations can be compared, it is necessary to reach an agreement as to the standardization of measuring conditions.

ERNST A. POHLE, M.D., Ph.D.

Diffraction of Hydrogen Atoms. Thomas H. Johnson. Phys. Rev., April 15, 1931, XXXVII, 847-861. (Reprinted by permission.)

Diffraction Patterns of a Beam of Hydrogen Atoms Reflected from LiF.—Improved technic in the photography of the diffraction patterns produced by the reflection of a beam of hydrogen atoms from a crystal of lithium fluoride has resulted in more complete patterns than those previously described by the author. The observed patterns are those expected on the assumptions (1) that the incident beam contains the distribution of wave lengths derived from the Maxwellian velocity distribution by the use of the de Broglie relation between wave length and velocity, and (2) that the surface of the crystal constitutes an impenetrable square array of scattering points with the arrangement and spacing of the ions of a single type as known from X-ray measurements.

Wave Length Distribution.—The intensity distributions in the diffraction patterns were measured, and were found to have maxima at positions in good agreement with those expected on the basis of the above assumptions.

Interpretation of Relative Intensities in the Different Orders.—The relative intensities in the observed orders are discussed in relation to the scattering coefficients of the two types of ions, and in relation to the dependence of the scattering coefficient on azimuth.

Diffraction by the Secondary Structure of the Crystal.—A secondary spectrum is described, arising from a lattice of wide spacing, the lines of which are parallel to the 100 cleaved edges of the crystal face.

MYOSITIS OSSIFICANS

Progressive Myositis Ossificans. J. H. Mather. British Jour. Radiol., May, 1931, IV, 207-210.

One additional case of progressive myositis ossificans is reported by the writer, who states that 149 cases have previously been recorded. Characteristic features of the disease are progressive and extensive ossification of the voluntary muscles without apparent cause, manifesting itself as a congenital condition or one developing in early life. The condition is often associated with defective anatomic or physiologic development (toes, fingers, stature, habitus, sex differentiation).

The disease usually first manifests itself by painful doughy swellings of the affected muscles, with development of plates of bone in these areas, occurring after subsidence of the pain and swelling. The proximal muscles of the limbs and those of the back are usually first involved, with later progressive involvement of other groups of voluntary muscles, although those of the face, eyes, tongue, heart, diaphragm, and sphincters are never involved. In contrast with traumatic myositis ossificans, removal of bone in an attempt to restore function has always been followed by prompt recurrence. The etiology is unknown, and no satisfactory therapy has to date been discovered.

The case herein reported is of particular interest because of the long interval of time during which the patient has been studied, the first X-ray having been taken in 1897, when the patient was two and one-half years old, at which time ossification in the pectoralis major, teres major, and latissimus dorsi muscles was noted. The additional X-ray illustrations indicate the patient's present condition at the age of thirty-six years. She is bedridden, although cheerful and able to feed herself, but showing extreme ossification of the muscles of the neck, back, shoulders, thighs, hips, and elbows; also microdactylia of both big toes.

The author calls attention to the fact that the ossification always begins in the muscle or tendon at its point of attachment to the bone, with never any ossification in the middle of the muscle or tendon.

J. E. HABBE, M.D.

PHYSICAL THERAPY

Physiotherapy: Modus Operandi. Publication Committee, Canadian Med. Assn. Jour., April, 1931, XXIV, 539-541.

This is the third in the series of papers contributed by the Canadian Radiological Society toward the education of the general profession in radiologic matters.

In previous articles it was shown that, properly used, with full knowledge of physiology and pathology, physical therapy can be used to the advantage of the patient and to no small degree the results can be predicted. If this be true, scientific physical therapy is not, as sometimes described, purely empirical.

With the discovery of the X-rays by Roentgen, in 1895, and the radio-activity of matter by Becquerel, in 1896, intensive study of the atom began. With such vigor has this study been pursued that we now know that the atom is divisible into two components, protons and electrons. It is well known that the electron can be displaced from the atom. The characteristic peculiarity of radio-active atoms, such as radium, is explained by the fact that they readily part with their electrons. An electron discharge from radium gives rise to the beta ray, and an electron discharge through the X-ray tube gives rise to the X-rays.

The discovery by Becquerel that radio-active substances could not be carried about on one's person with impunity gave rise to the study of short wave therapy. These energies were found to have the ability to destroy or inhibit cell function and even cell life, or to stimulate it. These powers are at the service of the radiotherapist who understands their manipulation and control. To treat malignancy, we take advantage of their lethal property whereby cell function and structure may be destroyed. Used in a less intensive manner, we can inhibit gland function. This is illustrated in the successful radiation treatment of toxic goiter and the hemorrhages of the menopause. The stimulating effect is used to advantage in functional amenorrheas and in treating many chronic states, the result of local disordered circulation, stasis, or fibrosis.

But what is the modus operandi? Short wave length therapy directed into tissues causes an emission of electrons. The tissue atom, having lost a portion of its negative charge, is no longer stable; it is now chemically active. Thus is produced the chemical effect in the tissues. These photo-electric and photochemical changes may be to the advantage or the detriment of the organism, according to the intensity and duration of the delivered radiation. The dosage is capable of variation at will by the therapist. To be helpful to the patient, it necessarily follows that the patient's pathologic state must have been accurately estimated. This necessity removes radiation therapy from the charge of empiricism.

The difference between the destructive effect of short wave therapy, as represented by radium, and long wave therapy, as represented by ultra-violet, is due to the degree of violence experienced by the atomic structure. The long wave length ultra-violet causes discharge of electrons from the outer atomic orbit, and produces beneficial effects. The short wave length radium expels electrons from the inner atomic orbit, and produces lethal effects.

Another factor in the type of effect produced is the varying sensibility of cells. The cell of embryonic type and the endothelial cell are particularly sensitive and readily destroyed by radiation. The same is largely true of cells undergoing mitosis and cells with hypermetabolic function. It is also well known that bone, muscle, and nerve tissues are more resistant to radiation. Similar variation in sensitivity and resistance is found in newgrowths.

L. J. CARTER, M.D.

Application of Physical Therapy Measures in the Treatment of Burns. Willis S. Peck. Arch. Phys. Ther., X-ray, Radium, June, 1931, XII, 327-333.

The author describes the use of heat, ultra-violet radiation, massage, and exercise in the

treatment of infected granular surfaces before and after skin grafting. It was found that in the use of ultra-violet radiation 70 per cent of the patient's skin erythema dose applied to the wounds gave the most satisfactory results. The effect of this radiation, applied according to the described method, is dependent upon the production of a mild active hyperemia, which increases nutrition and local anti-bactericidal activity, destruction of organisms immediately on the wound surface, and possibly a stimulation of cell growth.

Infected burned areas totaling over two hundred square inches of body surface per patient were prepared for skin grafting within less than three weeks. Practically no grafts were lost because of infection or poor nutrition. The results of treatment are illustrated by case histories and photographs. The titles of the first and third illustrations are incorrect, because the photographs show the patient after healing.

RADIATION SICKNESS

Radio-anaphylaxis in Normal Organisms. Luigi Cappelli. Radiol. Medica, September, 1930, XVII, 1084-1090.

In a previous experiment, the author concluded that roentgen sickness could not be ascribed to formation of foreign proteins originating from cellular disintegration. He continues his researches, however, to test whether the quantity of the hypothetical radioproteins, produced by radiation, is far greater than the quantity necessary to immunization, approaching, instead, the anaphylactic dose.

Experiments were performed on two groups of rabbits. The first was sensitized by six weekly injections of horse serum, and the second was given a similar series of roentgen treatments (54 r each). Of the different tests (pH, white cell count, alkaline reserve, and CO_2) performed immediately before the administration of serum or radiation and thirty minutes after the treatments, only the white cell count showed the typical decrease in the irradiated group. The susceptibility of the injected group was positively tested fifteen days after the last injection, but neither the injection of serum in irradiated animals nor intensive irradiation (325 r) of previously sensitized or irradiated animals caused a prophylactic shock.

The author concludes that roentgen sickness is caused neither by proteic disintegration nor by albumoses or peptons, which are its direct by-products.

L. MARINELLI.

RADIUM

Improved Method of Implanting Radon Seeds. Joseph Muir. Med. Jour. and Rec., May 20, 1931, CXXXIII, 503.

Interstitial radiation by means of removable metal radon seeds is now generally considered superior to all other forms of radium administration. This article describes a new method of implantation by which a high degree of accuracy in the spacing of seeds is obtained, and the planting of three seeds with a single puncture made possible. The simplicity and advantage of the technic is shown by several illustrations. In practically every deep-seated malignant neoplasm this technic will prove advantageous, although it must be varied to meet individual requirements.

W. W. WATKINS, M.D.

The Action of Radium on Carcinoma. Clinical Conference. Canadian Med. Assn. Jour., April, 1931, XXIV, 543, 544.

This is the report of a clinico-pathologic conference at the Montreal General Hospital. The material presented by L. J. Rhea was the tissue from two cases of carcinoma which had been treated by irradiation with radium.

The first case was a scirrhus carcinoma of the breast, which was considered inoperable and was treated by radium. The points considered were: (1) The effect of radium in the production of fibrosis, and (2) the result

of irradiation on the cancer cell. No more fibrosis was found than would have been expected in an untreated carcinoma of the breast. Neither were there noted any cell changes which might be attributed to radium.

The second case was a carcinoma of the rectum treated by radium, followed by a disappearance of the lesion, with later recurrence and fatal termination. The microscopic report was the same as in the first case. No noticeable effect of the radium was in evidence.

A. T. Bazin, in reviewing the cases, stated that he had lost a great deal of his former enthusiasm for radium treatment of cancer. In groups of cases collected over a five-year period it was found that radium had no marked advantage over surgery. It was pointed out by other participants in the discussion that radiation therapy has advantages in certain forms of cancer, namely, rodent ulcer and carcinoma of the cervix.

Dr. Ritchie, roentgenologist of the hospital, said that the lack of satisfactory response of tumor cells under certain conditions to either X-rays or radium was well recognized, but no satisfactory explanation had been offered. The consensus of opinion was, however, that the more embryonic the tumor cells were, the more satisfactory was their response to X-ray or radium.

L. J. CARTER, M.D.

The Use of Radium in Disturbances of the Internal Secretions, Especially in Basedow's Disease. Gudzent. Med. Klin., May 29, 1931, XXVII, 803-805.

It is known that introduction of very small doses of radio-active substances (for instance, 1/1000 to 1/100 milligram of radium) into the body causes a definite increase in the metabolism. This fact can best be explained by a stimulation of the thyroid. Other glands of internal secretion also seem to show increased function after very small doses of radium (sexual organs, suprarenals).

Direct radiation, with large doses of radium, leads to morphologic changes in the glands of internal secretion. The testes and ovaries are about five times more radium-sensitive than the skin. The loss of internal secretion from the ovaries often leads to very marked general changes, while in a man these alterations are absent. The thymus is almost as sensitive against radium rays, on account of the abundance of lymphatic tissue in it. The suprarenals can be damaged by large internal doses of thorium X or by radium rays. A typical picture of Addison's disease may be seen, if the dose is large enough. The normal hypophysis and thyroid gland are to a very slight extent radiosensitive, and only very high doses, which lead to destruction of the skin, damage these glands. The diseased hypophysis is apparently much more easily influenced by radium than the normal one. Tumors respond fairly well.

It is of interest that the author succeeded in removing severe characteristic symptoms by irradiation of the hypophysis in forty cases; the improvement took place from four to six weeks after the treatment. Seven hundred patients with diseases of the thyroid have been treated by the author during the last ten years. One hundred mg. of radium in 10 tubes each containing 10 mg., filtered with 1.5 mm. brass and 1 cm. galalit, were applied over the thyroid according to the case, up to 24 hours. The highest dose was three-fourths of a skin erythema. Sometimes this treatment was repeated in ten weeks and occasionally again after some months. In hypoplastic thyroid (without toxic symptoms) 43 per cent were cured; in toxic adenoma, 53 per cent (with improvement in 38 per cent); in exophthalmic goiter, 64 per cent, and in thyrotoxicosis 54 per cent (improvement in 36 per cent). Myxedema or hypothyroidism was not observed. These results can well be compared with surgical statistics. Radium treatment has no mortality compared with surgery. The treatment lasts not more than 24 hours and there is no loss of time for the patient. Roentgenotherapy is, of course, in principle the same as radium therapy; but the author prefers the latter on account of the

absence of reaction and better percentages of cure and improvement.

H. W. HEFKE, M.D.

RESPIRATORY TRACT

Infectious Asthma and its Relationship to Chronic Sinus and Pulmonary Disease. Joseph Harkavy and Fred Maisel. Jour. Am. Med. Assn., May 30, 1931, XCVI, 1843-1846.

Increasing clinical experience in the study of adult asthmatic patients leads to the conclusion that investigation for atopy is only one means of differentiating that from other commonly encountered forms: that a constitutional imbalance of the vegetative nervous system referable especially to the respiratory tract in which an allergic factor may coexist and be one of the many exciting agents of the paroxysm is suggested. When the allergic excitant is absent, other stimuli, particularly infections of the respiratory tract, may play the dominant rôle in initiating the attacks.

The extent of damage to the tissues of the nose, sinuses, bronchi and alveolar passages, following infection, have been demonstrated by histologic studies of autopsy material in asthmatic patients. A consideration of their cases points to the fact that the pathogenesis of asthma was infection of the upper and lower respiratory tract.

C. G. SUTHERLAND, M.D.

RICKETS (THERAPY)

Ultra-violet Light in California Summer Sunshine, with Special Reference to its Value in the Prophylaxis and Treatment of Rickets. John M. Frawley. Am. Jour. Dis. Child., April, 1931, XLI, 751-757.

Measurements of the ultra-violet rays in the sunlight at three different localities in California were made. A modification of Leonard Hill's acetone methylene blue method was used, and there was found to be a great variation in the ultra-violet content of the sunshine, depending on local climatic conditions. In the central part of California, where there is an unusually great amount of sunshine, there is a deficiency in the amount of ultra-violet rays. On account of the lessened proportion of ultra-violet rays to visible light rays and heat in the sunshine, the author considers it inadvisable in extremely hot climates to depend on "sun baths" for the prevention and treatment of rickets.

F. B. MANDEVILLE, M.D.

ROENTGENOTHERAPY

The Emergency Value of Roentgen Therapy in Pediatrics. Ira I. Kaplan. Arch. Pediatrics, May, 1931, XLVIII, 330-334.

Under this heading the author discusses briefly and seemingly extemporaneously such conditions as enlarged thymus, lymphosarcoma, tuberculous adenitis, toxic goiter, leukemia, sarcoma of the kidney, and malignant or benign bone lesions. He advises the use of high voltage (200 K.V.) therapy.

E. C. VOGT, M.D.

Ovarian and Testicular Cancers: Their Response to X-ray Treatment. J. H. Douglas Webster. Practitioner, June, 1931, CXXVI, 636-643.

The author emphasizes the high degree of malignancy and marked radiosensitiveness of ovarian and testicular cancers. Their high malignancy is shown by the results of operation. Only a four- or five-year "cure" of from 10 to 15 per cent can be claimed (Seitz). Metastasis is so much the rule in testicular carcinoma that with orchidectomy alone there are few exceptions to the statement that "the ultimate mortality is 100 per cent." With the radical operation the results are not as good as with castration and high division of the cord, followed by deep X-ray therapy to the lumbar gland area. The improvement possible with post-operative radiation is suggested by Heyman's figures in 32 cases, with a 65.6 per

cent five-year "cure." In Bumm's series of cases there was a two-year prolongation of life after incomplete operations over the life of similar non-radiated patients. Webster presents 70 cases of ovarian and testicular carcinoma, showing the value of X-ray therapy.

Regarding the ovarian neoplasms, the author feels that his results confirm the opinion of Heyman and others that post-operative radiation of these tumors will lead to improvement in the end-results. Follow-up of patients is essential as the smaller the "recurrence" the better is the chance for radiotherapy to give effectual assistance. Pre-operative, as well as post-operative radiation should be carried out. The former lessens the chance of dissemination of viable implants during the operative removal of fragile masses or cysts. In radiation treatment of later cases, the upper abdomen should not be neglected.

As to testicular carcinomas, the author's observations are in accord with those of Béclère and other French writers, who feel that even massive or many scattered testicular recurrences may disappear under X-ray treatment, and an apparent cure persist. Here, too, preoperative and post-operative radiotherapy are advised.

In this series the radiation factors were 200 K.V. (peak), 2 or 3 ma., 0.5 mm. Zn plus 1 mm. Al filter, from 75 to 100 per cent skin erythema doses, distance 30 cm., with symmetry apparatus. As a rule, the large-field methods and fractional doses have been employed. Heavier filtration, higher voltage, and continuous current may improve the results, particularly in the more resistant of the ovarian types of cancer.

J. M. Mora, M.D.

ROENTGEN INJURIES

Roentgen Carcinoma and Sarcoma of Man, with Report of a Case. Frederick W. Mulsow. Jour. Am. Med. Assn., June 13, 1931, XCVI, 2030.

A case is reported in which a sarcoma developed in one finger and one year later carcinoma occurred in another finger of a physician repeatedly exposed to X-rays. The occurrence of carcinoma and sarcoma in the same individual is not common.

It is well known that repeated roentgen injuries of man may be followed by carcinoma. There are few reports of sarcoma following roentgen injuries, although sarcoma has been produced experimentally by the X-rays.

A tumor appeared on the index finger, and resort was had to amputation. The microscopic diagnosis was fibrosarcoma. There has been no recurrence. The middle finger was removed later, the microscopic diagnosis being squamous-cell carcinoma.

C. G. Sutherland, M.D.

Successful Treatment of Roentgen Injuries by Under-water Massage. Karl Hoffner. Strahlentherapie, 1931, XL, 599.

Hot douches and massage applied under water are recommended by the author in the treatment of roentgen ulceration. He reports two cases that responded well to this therapy.

Ernst A. Pohle, M.D., Ph.D.

THE SINUSES (DIAGNOSIS)

The Diagnosis of Mastoiditis in Children. D. E. S. Wishart. Canadian Med. Assn. Jour., April, 1931, XXIV, 514-516.

To be able to diagnose the complications of latent mastoiditis is valuable, but it is far more important to be able to diagnose the latent mastoiditis before the onset of the many possible complications. When a patient's ear has been discharging for more than four weeks the physician should throw some of the responsibility on the shoulders of the otologist. In any case of prolonged ear discharge, in which the patient shows signs of going downhill, and other causes are absent, mastoiditis is present and an operation should be performed. The differential diagnosis is mainly from furunculosis.

Among the aids in making the diagnosis are the following:

1. *From the tenderness over the mastoid.* —Tenderness over the tip of the mastoid or

over the antrum close to the auricle, persisting or recurring after an incision of the ear drum, indicates surgical mastoiditis.

2. *From the appearance of the drum.*—The so-called "drooping" of the roof of the canal is a very reliable indication of surgical mastoiditis.

3. *From the quantity and character of the discharge.*—If the discharge is purulent and profuse and continues for an undue length of time, even though there is an absence of all other symptoms, mastoiditis is present. Such an otorrhea may subside, but very few of those which do subside but leave unfortunate sequelæ.

4. *From the temperature chart.*—If high temperature persists after an incision of the drum in ear discharge, the mastoid is involved.

5. *From the X-ray.*—In doubtful cases, an X-ray examination may be of great value. Both mastoids should be radiographed for comparison. Mastoiditis is present if a few cells are distinguished, if the cell partitions are absent or blurred, if large areas are without cell markings, or if the whole mastoid area is fogged. These findings are indicative of surgical mastoiditis only if there are confirmatory clinical symptoms.

L. J. CARTER, M.D.

THE SKIN (THERAPY)

The Use and Abuse of Radiation Therapy in Diseases of the Skin. Paul E. Bechet. Med. Jour. and Rec., Jan. 21, 1931, CXXXIII, 84.

The roentgen rays are of transcendent importance in the treatment of disease of the skin. We have fairly accurate knowledge of the nature, biologic effects, and therapeutic results of radiotherapy. The X-ray is exceedingly useful in many dermatoses, many of which may be cured or improved by its use. However, it is not a panacea, nor is it absolutely free from danger.

The best results are obtained in acne, tinea tonsurans, multiple idiopathic hemorrhagic sarcoma, mycosis fungoides, keloids, and the lymphodermas. Radiotherapy is of great value in lichen planus, psoriasis, lichenification, and restricted patches of chronic eczema, in granuloma annulare, sycosis, scrofuloderma, tinea barbæ and verruca plantaris. Its use in hypertrichosis is vigorously condemned.

W. W. WATKINS, M.D.

THE SKULL (DIAGNOSIS)

Hypertelorism: Report of Four Cases. William Anthony Reilly. Jour. Am. Med. Assn., June 6, 1931, XCVI, 1929-1933.

Hypertelorism is a developmental defect of the lesser wings of the sphenoid bone, which ossify early in uterine life and grow excessively. This causes typical widely separated eyes. The horizontal axes of the eyes are directed more laterally than normal. The skull is brachycephalic, this being a familial tendency and often an associated mental deficiency.

There are possibly four different forms of this syndrome. The facies is common to all; mental deficiency and familial tendency are variables.

The skull is characterized by a relatively small face and a large cranium, and the retroussé nose has a broad bridge which sets the eyes far apart. A high forehead completes the picture. Roentgen examination reveals the following characteristics: Intersutural bones—internasal, parietomastoid, and pterionic—the sutures being incomplete, with no digitations.

Nothing can be done directly for the condition. The essayist reviews thirteen cases found in the literature, and he is adding four additional ones to the series.

C. G. SUTHERLAND, M.D.

Craniocerebral Injuries. John S. Hodgson. New England Jour. Med., April 2, 1931, CCIV, 720-724.

Only 10 per cent of craniocerebral injuries demand surgical intervention. The roentgen-

ographic examination of the skull, while important, should be deferred if possible until the patient's condition will not be jeopardized. If a compound fracture is present or a depressed fracture is suspected, X-ray examination may be needed early. The author says: "Instead of belittling the value of X-rays and laying entire stress on the intracranial injury, I am more and more convinced of their importance." X-ray examination reveals the location, type, and extent of the fracture and may demonstrate extension into areas not known clinically. Occasionally it shows a fracture not anticipated. The medico-legal value of the X-ray need only be mentioned, as this is obvious.

Encephalography is becoming a very interesting procedure. It is possible by this method to show post-traumatic cerebral atrophy and many other changes within the cranium which can be determined in no other way.

W. W. WATKINS, M.D.

A Modified Technic of Radiographic Dissociation of Shadows Applied to the Study of the Skull. Alessandro Vallebona. Radiol. Medica, September, 1930, XVII, 1090-1097. 1097.

Interpretation of a radiograph of the skull is not very easy on account of the numerous shadows that are superimposed. The author thinks it advisable to rotate the skull around an axis which would be represented by the organ to be examined. In this way the shadows of parts situated elsewhere would not appear definite and would not interfere with the sharpness of the required image.

Abundant illustrative material is presented. The author advocates for this work the use of fine-focus tubes or the adoption of a microradiographic technic.

L. MARINELLI.

A Method of Study of Intracranial Hemorrhage in the New-born Infant. F. M. B. Allen and H. I. McClure. Arch. Dis. Childhood, April, 1931, VI, 97-100.

An emulsion of Röntyum (Kahlbaum) is injected in the carotid artery of infants postmortem and stereoscopic films of the skull taken that give excellent detail of intracranial vessels. The authors claim that by this method accurate localization of intracranial hemorrhage, even superior to postmortem examination, is possible. During injection a pressure of 230 mm. of mercury, which is gauged by means of an aneroid manometer, is advocated.

E. C. VOGT, M.D.

The Duration of the Roentgenologic Demonstrability of Cranial Fractures during Childhood. Werner Illig. Fortschr. a. d. Geb. d. Röntgenstr., January, 1931, XLIII, 76.

Numerous controlled observations led the author to the conclusion that in childhood cranial fractures heal osseously without demonstrable residue within nine months and less, while in the adult and in adolescence beyond the age of ten or twelve years, the fracture line can be demonstrated for many years or may not at all form osseous union. The author points out the necessity of early roentgenographic examination of the cranium whenever accidents have occurred, before traumatic epilepsy manifests itself.

H. A. JARRE, M.D.

THE SPINE (DIAGNOSIS)

Kümmell's Disease. Frederick W. O'Brien. New England Jour. Med., March 26, 1931, CCIV, 641-648.

There is a tendency to describe every wedge-shaped vertebral body accompanied by kyphos and shown by X-ray after an injury as an instance of Kümmell's disease. It must be borne in mind that several other conditions can produce such a deformity. Kümmell stated that the condition was caused by trauma, insufficient to produce fracture but which disturbed the nutrition of the bone so that atrophy of adjoining vertebral surfaces resulted, progressing until the deformity was produced. His argument was that great force was necessary to produce great fracture while his dis-

ease followed mild trauma. The author refers to Hanson's work on the spine *(Acta Radiol.,* 1926, V, 112-126) as explaining the changes following vertebral trauma. He also contends that what Kümmell described is an unrecognized, hence untreated, fracture of the spine, in which the trabecular structure has been broken down. Kümmell had made his observations before the X-ray had developed to its present-day degree of excellence. Modern technic should be able to show vertebral fractures very soon after spinal injury, even if the osseous injury should be overlooked at the primary examination. With early diagnosis and proper treatment the gibbus of Kümmell's syndrome should become as occasional as the hunchback of Pott's disease.

W. W. Watkins, M.D.

THE THYMUS (DIAGNOSIS)

An Analysis of the Data Collected by the Status Lymphaticus Investigation Committee. Matthew Young and Hurbert M. Turnbull. Jour. Path. and Bacteriol., March, 1931, XXXIV, 213.

In view of the importance of "status lymphaticus," particularly in regard to the exact part, if any, which it plays in the causation of sudden death, the Medical Research Council, in conjunction with the Pathological Society of Great Britain and Ireland, formed a Committee, in January, 1926, to collect information on a large scale on weights and measurements of the thymus gland.

The special objects of the investigation were primarily as follows: "(1) To establish, by means of a large series of weights and measurements, the standards of weight for age and proportion to body weight of the normal thymus at all ages, and (2) to investigate closely the precise cause of death in persons dying suddenly from unexplained or trivial causes where the only apparent abnormality was the presence of a large thymus."

The scheme evolved by the Committee included the appointment of a number of investigators in certain large cities to collect detailed records. Insofar as possible the cooperation of all pathologists and practitioners who performed postmortems was enlisted.

The cases in which information was specially desired were divided into two categories:

"*(a)* Cases of sudden death in apparently healthy persons of any age, including deaths from accident, and *(b)* cases of death in persons of 15 years or over who had an apparently glandular thymus."

More or less complete records of 710 cases were collected. Of these, 30 had to be discarded on account of defective information as to the cause of death, leaving 680 for analysis.

All available material was then examined by one member of the Committee and classified according to the cause of death and pathologic conditions found. He regarded as normal those cases in which death was due to accident, such as drowning, burns, hemorrhage, poisoning, etc., in which no associated disease was mentioned, or, if present, appeared to be quiescent or insignificant. He regarded and classified as abnormal cases that had some associated disease or abnormal condition which might have had something to do with loss of life. Some 464 cases were considered normal, of which 279 (187 males and 92 females) were under 16 years of age.

Taking into consideration the authors' own studies, as well as those of other well known investigators of this subject, certain fairly concise deductions were drawn. They think, despite certain apparent divergencies, that the average weight of the normal thymus, as well as the mean percentage proportion of thymic weight to body weight in the different age groups from 1 year upwards, was well established.

The data of this Committee do not seem to show any definite relationship between thymic weight and encirclement of the trachea by thymic tissue. Neither did it seem that any significance could be attached to sexual differences. There appears to be little, if any, association between the weight of the thymus and the amount of lymphoid tissue in the various parts of the body, nor can any signifi-

cance be attached to the amounts of lymphoid tissue in any part of the body as compared with that in other parts.

In the normal subjects under 16 years of age, the Committee's data do not provide any evidence that the proportion of deaths from what may possibly be considered inadequately explained causes, is greater in the group of cases in which the thymus may be described as showing a tendency to an abnormally large size than the others. In subjects with hyperthyroidism there is evidence that the average gross weight of the thymus is distinctly above the normal. There is no evident association between arterial hypoplasia and an abnormally large thymus. The Committee's relatively few data do not suggest that the weight of the thymus is abnormal in males with evidence of feminism, as indicated by the distribution of pubic hair.

The authors' concluding statement is as follows: "In the opinion of the Committee, the facts elicited in the present inquiry are in harmony with those of Hammar (1926 and 1929) and Greenwood and Woods (1927) in affording no evidence that so-called 'status thymico-lymphaticus' has any existence as a pathological entity."

E. C. Vogt, M.D.

A Contribution to the Diagnosis of Thymomas. A. M. Rabinowitsch. Fortschr. a. d. Geb. d. Röntgenstr., January, 1931, XLIII, 71.

This is a case report of a thymoma which originally was misdiagnosed as aneurysm of the aorta in the presence of an old scirrhotic apical tuberculosis.

A short discussion is given as to the classification of tumors of the thymus, their differential diagnosis, and roentgenologic symptomatology. The statement is made that the response of these tumors to radiation therapy is quite inconsistent.

H. A. Jarre, M.D.

THE TONSILS

Electrothermic Extirpation of Tonsils: The End-results with a Newer Technic. Lewis J. Silvers. Arch. Phys. Ther., X-ray, Radium, June, 1931, XII, 343-346.

The author describes in detail the preparation of the tonsil and surrounding region for electrocoagulation. A bipolar current is used, the inactive electrode being placed on the anterior surface of the neck. The pointed active electrode is placed below the middle of the exposed surface of the tonsil to a depth of one-eighth of an inch and the current (about 450 milliamperes) applied until the circumferential area becomes white. The process is repeated until all of the exposed tonsillar surface has been treated. The tissue below the coagulated area is next desiccated with a monopolar (Oudin) current, after which the surface is desiccated to prevent oozing. Patients are treated at weekly intervals until the tonsil is completely removed.

Willis S. Peck, M.D.

TUBERCULOSIS (DIAGNOSIS)

Healing of Pulmonary Tuberculosis. E. A. Beaudet. United States Vet. Bureau Med. Bull., July, 1931, VII, 643-647.

The author concludes, from a study of serial roentgenograms, that the two modes of healing which occur in pulmonary tuberculosis are resolution or absorption and fibrosis. While the most common form of healing is by absorption, it is believed that fibrosis is a stage in the process of healing and depends on the character of the lesion and the natural resistance of the patient.

In the tubercle the bacilli are surrounded by a more or less circumscribed conglomeration of white blood cells and exudation. On the roentgenogram this area appears as a definite, hazy shadow, with indefinite demarcation, the density fading gradually from the center to the periphery. This is in contrast to the sharp

outline of a fibrosed tubercle. The author is of the opinion that as soon as the infection is controlled, the exudate is gradually absorbed and leaves no visible trace on the roentgenogram. The rate of clearing depends, however, on the amount of involvement and character of the lesion.

Serial roentgenograms have further shown that fibrosis and the walls of cavities may be completely absorbed and very little or no evidence may remain of an extensive involvement. For this reason, the author believes that roentgenograms made during the course of the infection are the most reliable proofs of the extent of the lesion. In his series of 147 patients, 32.5 per cent of cavities disappeared or healed.

While fibrosis is still considered by some to be an index of the resistance of the patient to tuberculosis, it is the author's opinion that it is, rather, an index of the low virulence of the tubercle bacilli, and that it should be considered more of a stage in the process of healing. Fibrosis is more usually found in chronic invalids whose condition has been stationary for years and who frequently have not followed any treatment intelligently. When such cases are properly treated, remarkable clearing, with absorption, frequently results, with complete recovery. Case records and reproductions of roentgenograms are submitted by the author.

J. N. Ané, M.D.

Outline of the Diagnosis and Treatment of Intestinal Tuberculosis. Lane B. Kline. United States Vet. Bureau Med. Bull., May, 1931, VII, 445-453.

In a study of 1,078 cases of pulmonary tuberculosis, complicated in 233 instances by tuberculosis of the intestines, the author concludes that the X-ray examination was the most important diagnostic aid.

The author's technic is based on the method of Brown and Sampson. At 8 A.M. the patient is given a barium meal and immediately fluoroscoped. At the end of six hours he is again fluoroscoped in the supine and prone positions. The cecum is outlined with a skin pencil, and one-third of a 14×17 film is used for the exposure, the unexposed portion being covered by a lead screen. In like manner, seven- and eight-hour exposures are made on the same film. A twenty-four-hour roentgenogram is made the following morning.

A combination of the fluoroscopic and roentgenographic procedures is the ideal method in the X-ray diagnosis of this condition. The author especially stresses the importance of a careful and standard technic and advises a conference between the roentgenologist and clinician before making a diagnosis.

The basic point in the X-ray diagnosis revolves about the altered motility of the barium meal, brought about by segmental spasm of the bowel with distal hypermotility. The filling defect noted in these cases is an index of irritability, but it does not measure the extent of ulceration in all cases. While this filling defect phenomenon is predominantly present throughout the period of observation, its form and degree may constantly change. The proximal colon has been the first and most reliable intestinal segment to be studied in these cases because of its stability of outline, normally slow motility, visibility, and most frequent involvement. Attempts to interpret filling defects beyond the hepatic flexure in terms of tuberculosis are unsafe and disappointing.

While clinical symptoms should always be carefully noted, it should be remembered that there is no pathognomonic symptom-complex of intestinal tuberculosis. Treatment follows the line of rest, heliotherapy, diet, vitamins, drugs, and psychotherapy.

J. N. Ané, M.D.

Perforating Caries of the Ileum with Transparietal Flow Caused by Intra-pelvic Abscess of the Gluteal Region. Francesco Satta. Radiol. Medica, October, 1930, XVII, 1179-1183.

Primary tuberculosis of the ileum is very rare. It is, in most cases, due to adjacent lesions of osteo-articular nature. The author describes two cases of primary tuberculous

localization in the iliac fossa, with ulceration or erosion of the wall. These anomalies were aggravated by intrapelvic abscesses of the internal pelvic fossa, located under the iliac muscle, which were first noticed in the gluteal region.

L. MARINELLI.

Radiologic Appearance of Pulmonary Tuberculosis Associated with Surgical Tuberculosis. Mario Lambranzi. Radiol. Medica, October, 1930, XVII, 1183-1188.

From the clinical point of view, these forms present a strict analogy with the fibro-granular tuberculosis of Bernard and Seyé and with Bard's granulitis. The association with surgical lesions brings to the lungs a stage typically fibrous, having, usually, a long duration. It seems to present no characteristic symptoms, especially during the first stages.

The formation of non-disseminating nodules of rather sclerotic or involutive nature may, in the author's opinion, explain the fact that surgical tuberculosis represents an inhibiting source, having the property of retarding a violent and rapid spread of infection in the lungs.

L. MARINELLI.

Cases of Roentgenologically Studied Gastric Tuberculosis. Axel Renander. Acta Radiologica, 1930, XI, 636-645.

The incidence of tuberculosis of the stomach, even in individuals with clinical tuberculosis, is small, ranging from 0.5 to 2.1 per cent. Some of the various explanations which have been advanced for the fact that tuberculosis of the stomach is so uncommon, even with individuals who are swallowing sputum laden with tubercle bacilli, are as follows: the small number of lymphatics in the stomach; defects in the gastric mucosa; the presence of free hydrochloric acid in the stomach, and the mucus covering the lining of the stomach.

It is very difficult to distinguish between primary and secondary infections of the stomach. The possible paths of infection of the stomach are: (1) Through the mouth; (2) through the blood vessels; (3) through the lymphatics, and (4) from the serosa. The principal forms of tuberculosis of the stomach are the ulcerative, the hypertrophic, and the inflammatory.

Hemorrhage and perforation are not commonly seen, but occasionally fistulæ are formed. Fibrotic stenosis is common in the hypertrophic form. The symptomatology is not characteristic, and the prognosis is poor.

When the local conditions permit and the general condition of the patient is favorable, resection is better treatment than gastro-enterostomy or the usual conservative therapy.

The author describes in detail three illustrative cases, in two of which a resection of the part of the stomach involved was done and in the third a gastro-enterostomy. X-ray examination of the gastro-intestinal tract in these cases showed in the first patient a cylindrical narrowing of the pars media, in the second case, an infiltration of the stomach wall in the prepyloric region, and in the third case, irregularity of the duodenal cap. The author feels that possibly with greater experience in the study of reliefs of the gastric mucosa the radiologist could make a presumptive diagnosis in this type of case.

ALAN L. HART, M.D.

Acute Exacerbation of Chronic Tuberculosis. C. A. Anderson. United States Vet. Bureau Med. Bull., June, 1931, VII, 561-563.

The author describes briefly the manner of the onset of the acute exacerbations in chronic tuberculosis. In cases of pulmonary tuberculosis with well-marked clinical reaction, in which there is the foundation of a good constitution and normal resistance, there tends to be a progressive increase in immunity until the condition is reached in which toxemia and other manifestations diminish and disappear. When this condition is reached, with the lesions and toxins walled off, the stimuli which act to promote the formation of immunity factors gradually decrease. The natural defenses of the body having become less active, there is

a breach somewhere in the protective fibrous wall of the invaded area, and the toxins reach the circulating media of the body, producing the symptom-complex spoken of as toxemia.

The recognition of an acute exacerbation and differentiating it from the onset of an acute infectious disease are of utmost importance. The history, physical examination, and roentgenograms should be carefully studied. The X-ray findings in an acute exacerbation of chronic tuberculosis are those of a recently established lesion, extending in some direction from the older organized pathology.

The general treatment is similar to that of infectious diseases, and complete rest and quiet are of the utmost importance.

J. N. Ané, M.D.

Tuberculosis and Köhler's Disease. D. M. Faulkner. Jour. Bone and Joint Surg., April, 1931, XIII, 369-372.

A case of Köhler's disease is reported in which biopsy has proved that the lesion was tuberculous. The patient, a child of five years, limped and had a painless swelling at the inner side of the left ankle. Roentgenograms were typical of Köhler's disease of the scaphoid. It was found several months later that the ankle had become red, swollen, and painful. At operation, seven months after onset and four months after the acute flare-up, the scaphoid was excised and microscopic diagnosis of bone tuberculosis made.

Paul C. Hodges, M.D.

The Main Roentgenologic Types of Lung Tuberculosis and Their Differential Diagnosis, with Special Consideration of New Developments in Clinical and Pathologic Anatomy. Franz Loben. Med. Klin., May 22, 1931, XXVII, 763-765.

The diagnosis of tuberculosis of the lungs has been definitely improved after the introduction of the roentgen examination; one can follow the course of the disease *in vivo*. The early diagnosis, by means of the X-rays, has been a very valuable factor in the fight against tuberculosis. The roentgenologic diagnosis is perhaps superior to all other methods. Classification of the different roentgenologic appearances, with consideration of the clinical and pathologic-anatomical viewpoint, has been given by different authors. Three main groups can be distinguished, as follows:

(1) The infiltrative processes and their localized sequences; (2) the disseminated forms; (3) the ulcerative, cavernous, mostly exudative phthisis, or the fibrotic, cirrhotic, mostly productive phthisis.

A definite boundary cannot always be established. Grouping the cases of lung tuberculosis as much as is feasible in such a way makes the diagnosis comparatively simple. The different roentgenologic appearances of the different groups are described, and differential diagnostic points are considered.

H. W. Hefke, M.D.

Chronic Pulmonary Infections in Childhood. Allen K. Krause. Ann. Int. Med., May, 1931, IV, 1424-1440.

A growing understanding of tuberculosis in early life casts increasing doubt on any idea of unusual or excessive susceptibility to tuberculosis during the formative years.

The lungs of infants and children provide focal soil for tubercle bacilli as frequently as do those of adults, while their lymphatic adnexa are the most common reservoirs of infection.

The prognosis of tuberculosis in the lungs or elsewhere in the body improves in direct proportion to our ability to recognize it in its early stages. The author makes a strong plea for tuberculin testing in pediatrics, and states that the more obscure an ailment (with earmarks of infection) remains, the closer one is approaching a diagnosis of tuberculosis. And it is here that tuberculin's evidence grows more compelling, for a positive test gains in meaning as other possibilities dwindle.

The author stresses the fact that much ill health in childhood, now passing for upper tract infection, is actually the expression of

chronic intrapulmonary infection, and emphasizes the extreme importance of bronchiectasis as being more disabling than tuberculosis and less amenable to permanent healing.

Symptomatology suggesting an oversusceptibility to colds is a prominent feature of cases with demonstrable non-tuberculous focal infection, and this indicates the need of an exhaustive search for pulmonic focal infection. These focal infections can progress into bronchiectasis or to lung abscess, as well as a tendency to recurrent bronchopneumonia.

CHARLES H. DEWITT, M.D.

TUBERCULOSIS (THERAPY)

The Use of the Cystoscope in Tuberculosis of the Bladder. Louis Rene Kaufman. Urol. and Cutan. Rev., May, 1931, XXXV, 294-302.

The author stresses the importance of cystoscopy in tuberculosis of the urinary tract, not only for accurate diagnosis, but, as well, for defining and establishing the relationship between lesions of the upper tract and the bladder. Cystoscopic evidence of tuberculosis of the bladder is found characteristically in the trigone and ureteral watershed. It is unilateral rather than diffuse. In this condition the ureteral aperture becomes edematous, surrounded by peripheral redness, and the watershed soon shows loss of luster. On the other hand the walls may be contracted and narrowed irregularly. The pyelogram, in some instances, may show extensive beading and rigid straightness of the ureter.

The search for the tubercle bacilli should be started early and attentively followed, for it will frequently demand repeated examinations. In the author's series, tubercle bacilli were recovered in 75 per cent of his cases.

While unnecessary instrumentation should be avoided, the author believes that the dangers of pyelography in tuberculosis of the urinary tract have been grossly exaggerated. He has found the pyelogram of great value and without danger if over-distention is avoided and all of the sodium iodide is removed. The normal kidney should always be examined by means of pyelography before removal of the involved kidney is considered. The ureterogram, likewise, is of value in determining pathology and in studying occlusion of the ureter. Where retrograde pyelography is impossible and cystoscopy inconclusive, the author believes that intravenous pyelography gives very valuable information. It not only demonstrates the entire tract, thus visualizing as well the sound kidney, but affords information as to relative function and the renal capacity of the sound kidney.

J. N. ANÉ, M.D.

The Cavity in Pulmonary Tuberculosis. Max Pinner and Marian E. Parker. Am. Jour. Roentgenol. and Rad. Ther., April, 1931, XXV, 454-463.

Pulmonary cavities may, in the process of fibrosis, be spontaneously obliterated, but much more often this process unaided by surgical intervention of some form will result in a stiff, non-collapsible wall, with a permanent cavity, where was once only an initial loss of lung tissue. The histologic structure of the cavity wall is, as can be readily understood, the most important factor in determining the appropriate time for therapeutic intervention.

The authors again present their classification of cavities, emphasizing especially differences in the walls of the three types: (1) The multiple small cavities in infiltrated parenchyma have no reticulum or connective tissue fibers surrounding them, hence have no actual wall structure; (2) the round or oval cavity, which shows itself on the film as a perfect oval or circle, has a thin layer of concentrically arranged young connective tissue fibers for its wall; (3) the fibrotic irregular cavity has a thick walled layer of interwoven connective tissue fibers, frequently hyalinized, for its wall. The last type is usually found in the extreme apices.

The authors show by illustrations the expected course in the ordinary rest treatment and also give tabulations from other writers of series of cases in which phrenicectomy or

artificial pneumothorax was instituted in the presence of cavity formation. They show convincingly that the success of cavity collapse by active intervention depends greatly upon the amount of fibrosis in the cavity wall, the greater the fibrosis the more difficult the collapse will be.

Since, therefore, both prognosis and therapeutics depend so largely on the condition of the cavity wall, the authors believe that more attention should be paid in roentgenologic study of cavities in pulmonary tuberculosis to the cavity wall than to the size (within limits) and location.

J. E. HABBE, M.D.

Ultra-violet Radiation in Tuberculosis of the Lungs. G. Sepke. Med. Klin., May 22, 1931, XXVII, 771.

The opinions about employing ultra-violet radiation in tuberculosis of the lungs are not uniform. Some, out of fear of focal reaction, do not irradiate at all, while others employ this method of treatment too often. The more active types of lung tuberculosis, especially the exudative forms, often react unfavorably upon even slight stimuli and should be excluded from this treatment. The productive and less active types receive benefit from it. Sputum examination, temperature records, the sedimentation test, and roentgenologic examination help to make the decision of indication for ultra-violet irradiation. One should begin with comparatively small doses, being more careful than in other diseases not to get a marked reaction. Treatments are given every three to five or seven days, depending upon the reaction.

Sixteen hundred patients have been treated in the Sanatorium Oderberg, four hundred cases being reported in this paper. Reactions were encountered occasionally, and cases of open lung tuberculosis had to be treated with the greatest caution. The impression of the author is that ultra-violet irradiation has led to definite improvement and is to be recommended. The treatment of tuberculosis by natural sunlight requires the same consideration and should be given only under medical supervision.

H. W. HEFKE, M.D.

TUMORS (DIAGNOSIS)

Krukenberg Tumors of the Ovary, with Report of a Case Secondary to Adenocarcinoma of the Jejunum. A. E. Bennett and M. Douglass. Am. Jour. Obst. and Gynec., January, 1931, XXI, 91-96.

This type of tumor was first described by Krukenberg, in 1895. It is a bilateral ovarian tumor associated with a primary lesion in the gastro-intestinal tract, usually the stomach. Major, in 1918, pointed out three possible ways of dissemination of the tumor from the upper gastro-intestinal tract: (1) Retrograde metastases through the lymphatics along the aorta and iliac vessels and by blockage of the lymph glands to the ovaries; (2) peritoneal dissemination, it being well known that particles of coloring matter placed in the peritoneal cavity are picked up by the ovaries; (3) blood stream metastases.

The authors report a case which is primary in the jejunum. The patient died in spite of two extensive operations. The authors do not discuss radiation therapy in Krukenberg's tumors, although I believe these tumors have been reported as being radiosensitive.

JACOB H. VASTINE, M.D.

Subdural Hematoma Shown by Encephalography. F. G. Lindemulder. Am. Jour. Roentgenol. and Rad. Ther., April, 1931, XXV, 512-514.

A case is reported, with illustrations, of extensive subdural hematoma occurring in a young man, 20 years of age, with symptoms developing a few months after two injuries to the head. Clinically, a hematoma on the left side was suspected, and trephine openings were made in the left frontal and parietal regions, but the dura mater and cerebral cortex appeared normal and the ventricle was found collapsed, hence no air was injected. Two days later an encephalography was successfully performed, 125 c.c. of cerebrospinal fluid being withdrawn and 140 c.c. of air

injected. A markedly dilated left ventricle, with diffusely compressed and displaced right ventricle, was shown, and at subsequent operation a large subdural hematoma covering the frontal, parietal, and tempero-sphenoidal regions was successfully removed.

J. E. HABBE, M.D.

Mixed Tumors of the Parotid Gland. Edwin A. Merritt. Am. Jour. Roentgenol. and Rad. Ther., April, 1931, XXV, 507-511.

The author reviews the literature with reference to the place of radiation therapy in mixed tumors of the parotid gland. Ten new cases with follow-up or end-results are reported. It is the author's opinion that, except for small encapsulated tumors, surgical removal is seldom successful, and all other tumors are treated more effectively by combined radium, usually in the form of radium seeds implanted, and high voltage roentgen rays.

J. E. HABBE, M.D.

ULCER (ETIOLOGY)

A Discussion of the Occurrence of Benign Ulcer on the Greater Curvature. John Sproull. Am. Jour. Roentgenol. and Rad. Ther., April, 1931, XXV, 464-473.

The author reviews the literature on benign ulcer on the greater curvature of the stomach and presents a case of suspected benign tumor with apparently a crater formation on the greater curvature of the stomach of a young woman, 24 years of age. His own case, which, on one occasion, showed peristalsis passing through the segment involved and which showed no increase in size over an interval of four months, proved by biopsy and subsequent course to be carcinoma, although the lesion was not suspected of being malignant at the time of the first operation and local removal of the lesion. By careful analysis of many of the cases reported in the literature as benign ulcer of the greater curvature, the writer shows that the diagnosis is often not justified, being supported only by suggestive roentgen findings or exploration without biopsy or subsequent check-up. He, therefore, feels it unwise for the roentgenologist ever to make a diagnosis of benign ulcer in the presence of a crateriform lesion on the greater curvature of the stomach because of the extreme rarity of such a lesion in this location.

J. E. HABBE, M.D.

ULCER (PERFORATING)

Roentgen Significance of Gas under the Diaphragm: Unusual Case, with Discussion. E. L. Jenkinson and I. G. Ellis. Am. Jour. Surg., October, 1930, X, 93-96.

The authors report an interesting case in which, by X-ray examination, gas was found under the diaphragm, the source of the gas being undemonstrable even on laparotomy. The suggestion was advanced that the patient may have had a small perforating ulcer of the duodenum through which the gas escaped, following which the lesion became walled-off by adhesions. The perforation was apparently very small and only a localized peritonitis followed.

Ordinarily, the radiologic demonstration of gas under the diaphragm (in the absence of injury) means that there has been either a rupture of a hollow viscus or a fistulous tract between the lungs and the peritoneal cavity. Vaughan and Singer are quoted as stating that almost without exception every acute abdominal condition with a free gas bubble is a case of perforative peritonitis from rupture of a gas-containing viscus. The literature is briefly reviewed.

J. M. MORA, M.D.

ULTRA-VIOLET LIGHT

The Use of Ultra-violet Light and Calcium Salts in Epilepsy. P. J. Borrows. United States Vet. Bureau Med. Bull., July, 1931, VII, 661-663.

The author attempted to determine whether electrotherapy, in the form of ultra-violet irradiations, and calcium therapy could influence the frequency or severity of epileptic paroxysms. Eleven patients were included in this study. Of these, four were hospital patients, showing epileptic deterioration, and three were school children, varying in age from 10 to 13 years. Each patient was irradiated for 20 minutes once daily with an air-cooled quartz lamp. The exposures were made at a maximum distance of 40 inches, both front and back. Ten grains of calcium carbonate were given three times a day. At first, one grain of luminal was administered twice daily. This was gradually diminished to the lowest possible dose necessary for the sedative action. Magnesium sulphate was also given in doses of one ounce of the saturated solution twice weekly.

The author concludes that ultra-violet light in conjunction with the calcium salts does produce beneficial results to a slight degree in epileptic patients.

J. N. Ané, M.D.

Excessive Ultra-violet Irradiation: Effect on the Nutrition and the Endocrine Glands of Rats. Alfred F. Hess and Philip E. Smith. Am. Jour. Dis. Child., April, 1931, XLI, 775-782.

Two series of rats were irradiated with the mercury vapor lamp for a period of five or six months, or given viosterol. Male as well as female animals were used. Those in the first series were litter mates, and those in the second, although not litter mates, were the progeny of the first. The authors used three intensities of irradiation: mild, moderate, and severe. Viosterol was given in small as well as in excessive amounts. The main object of the experiment was to note whether prolonged and intense irradiation or large doses of viosterol had a deleterious effect on the animals, as evinced by the rate of growth and the size and appearance of the endocrine glands.

The growth of the animals subjected to marked intensities of ultra-violet irradiation or given amounts of viosterol was as good as that of animals which had lived under similar conditions, but which had not been subjected to irradiation or given viosterol. At necropsy no difference was noted by the authors between the endocrine glands of the treated and those of the untreated animals.

F. B. Mandeville, M.D.

Absorption of Saturated Fatty Acids in the Ultra-violet Region. O. Hartleb. Strahlentherapie, 1931, XXXIX, 442.

The Isolation and the Chemo-physical Nature of Vitamin A. Hans Seel and F. Dannmeyer. Strahlentherapie, 1931, XXXIX, 449.

In the first paper, it is reported that a number of fatty acids show a selective absorption in the region of from 2,700 to 2,800 Ångströms. A mathematical relation has been advanced by Lederer; the calculated values check reasonably well with the experimental results.

The application of the physical findings led Seel and Dannmeyer to the conclusion that Vitamin A belongs also to the group of stearins. The synthetic as well as the natural Vitamin A showed selective absorption at 3,270 and 2,930 Ångströms.

Ernst A. Pohle, M.D., Ph.D.

CONTENTS OF ABSTRACTS IN THIS ISSUE, LISTED ALPHABETICALLY BY AUTHORS

AKSELRAD, LEON. About the Echinococcus in Bones 602

ALBERTI, W. The Roentgenologic Demonstration of Varices in the Duodenal Bulb..... 627

ALBRECHT, FRITZ. A New Electric Pyranometer for Measurement of the Sun and Sky Radiation 639

ALLEN, F. M. B., and MCCLURE, H. I. A Method of Study of Intracranial Hemorrhage in the New-born Infant..... 647

ANDERSON, C. A. Acute Exacerbation of Chronic Tuberculosis 651

ANZILOTTI, ALBERTO. Diverticular Images of the Stomach 626

ASTI, MARIO LUIGI. Observations on Measurements in Surface Radium Therapy..... 639

BANK, H. E. Syphilis of the Aorta and Lung with Atelectasis 619

BARCLAY, A. E. The Normal Mechanism of Swallowing 625

BARRETT, ERIC GEORGE VICTORY (*with* TERREY, HENRY) 608

BATES, CLARENCE E. Bilateral Spontaneous Pneumothorax 617

BAUMGARTEN, S. Radiography in Ear Diseases 623

BEAUDET, E. A. Healing of Pulmonary Tuberculosis 649

BECHET, PAUL E. The Use and Abuse of Radiation Therapy in Diseases of the Skin..... 646

BELLUCCI, BRUNO. A Contribution on the Etiology and Radiologic Differential Diagnosis of Diverticula of the Esophagus..... 624

BENADE, J. M. Cosmic Radiation and Radioactivity 616

BENEDICT, EDWARD B. Carcinoma in Osteomyelitis 604

BENNETT, A. E., and DOUGLASS, M. Krukenberg Tumors of the Ovary, with Report of a Case Secondary to Adenocarcinoma of the Jejunum 654

BERG, HANS HEINRICH. About Obscure Hernias and the Insufficiency of the Esophageal Hiatus 629

BERGER, HEINZ (*with* GFRÖRER, O.)..... 633

BERNARD, L. J. Esophageal Stricture..... 624

BERTEL, G. Radiographic Methods for Exact Diagnosis of Affections of the Large Intestine 627

BERTRAND and LABEAU. Radiotherapy in the Treatment of Angina Pectoris..... 635

BIANCHINI, ALESSANDRO. Diaphragmatic Hernia 622

BOLDINGH, W. H. (*with* VAN DER TUUK, J. H.).. 611

BORDIER, H. Radical Treatment of Prolapsed Hemorrhoids by Diathermy..... 623

BORROWS, P. J. The Use of Ultra-violet Light and Calcium Salts in Epilepsy..... 655

BORSOTTI, PIER CARLO (*with* FOÀ, ARRIGO)..... 620

BOTTGER, TH. (*with* BUTZ, H.)..... 612

BREDNOW, W. The Autoplastic Function of the Gastric Mucosa 599

BRIGGS, HENRY. A Note on the Mineralogy of Coal as Suggested by X-ray Examination.... 611

BROWN, HENRY P., JR. Subphrenic Abscess..... 636

BUNDY, HARRY E. Diverticulum of the Esophagus 628

BUTLER, P. F., and RITVO, MAX. Extra-bowel Pathology 628

BUTZ, H., and BOTTGER, TH. The Ultra-violet Rays of Artificial Light..... 612

CAMPBELL, MEREDITH F. Complications of Gonorrhea: Peri-urethral Abscess, Stricture, Arthritis 599

CAMPBELL, WILLIS C. The Physiology of Arthroplasty 625

CAMPLANI, MARIO. Further Contributions to the Knowledge of Skeletal Alterations in Tabes Dorsalis 601

Canadian Medical Association Journal. The Action of Radium on Carcinoma..... 642

CAPOCACCIA, MARIO (*with* VALLEBONA, ALESSANDRO) 600

CAPORALE, LUIGI. Primary Carcinoma of the Ureter with Atrophic Hydronephrosis..... 631

CAPPELLI, LUIGI. Radio-anaphylaxis in Normal Organisms 642

Idem. Radioproteins and Radio-anaphylaxis in Cancerous Patients Treated by Radiation Therapy 605

CATHERWOOD, A. E. (*with* MACK, H. C.)..... 634

CHIKASHIGE, MASUMI, and YAMAMOTO, TOSHIMICHI. The Crystal Structures of the Compounds Formed in the Antimony-cadmium System 609

CRAIK, JAMES (*with* MILES, FRANK D.)..... 616

DANNA, JOSEPH A. The Treatment of Empyema by Aspiration and Air Replacement without Drainage: Review of Thirty-five Cases 620

DANNMEYER, F. (*with* SEEL, HANS)..... 656

DAVIS, MURRAY B. Intestinal Obstruction from Eating Bran 627

DERKSEN, J. C. (*with* KATZ, J. R.)..... 615

DESMAROUX and MATHIEU. The Structure of Nitrocelluloses 609

IDEM. X-ray Study of the Gelatinization of Nitrocellulose 607

DOUGLASS, M. (*with* BENNETT, A. E.)..... 654

DRIER, ROY W. X-ray Study of the Copper End of the Copper-silver System..... 608

DYES, OTTO. Roentgen Relief of the Gastric Mucosa 629

EDITORIAL, *Journal American Medical Association.* Loss of Bone Salts during Scurvy..... 601

EIDINOW, ALBERT. The Technic of Surgical Diathermy: Describing a New Electrode..... 622

EKMAN, WALTER. Structural Analogies of Binary Alloys of Transition Elements and Zinc, Cadmium, and Aluminum..... 607

ELLIS, C. D., and SKOBELTZYN, D. Methods of Investigating the Intensities of γ-rays..... 608

ELLIS, I. G. (*with* JENKINSON, E. L.)..... 655

FAULKNER, D. M. Tuberculosis and Köhler's Disease 652

FENICHEL, NATHAN M. Tension Pneumothorax with Subcutaneous Emphysema: The Mechanism of Tension Pneumothorax..... 617

FISHER, RALPH L. Non-tuberculous Spontaneous Pneumothorax: with Report of Cases..... 618

FOÁ, ARRIGO, and BORSOTTI, PIER CARLO. Researches in Radiologic Morphology of the Sphenoidal Sinuses by Contrast Media..... 620

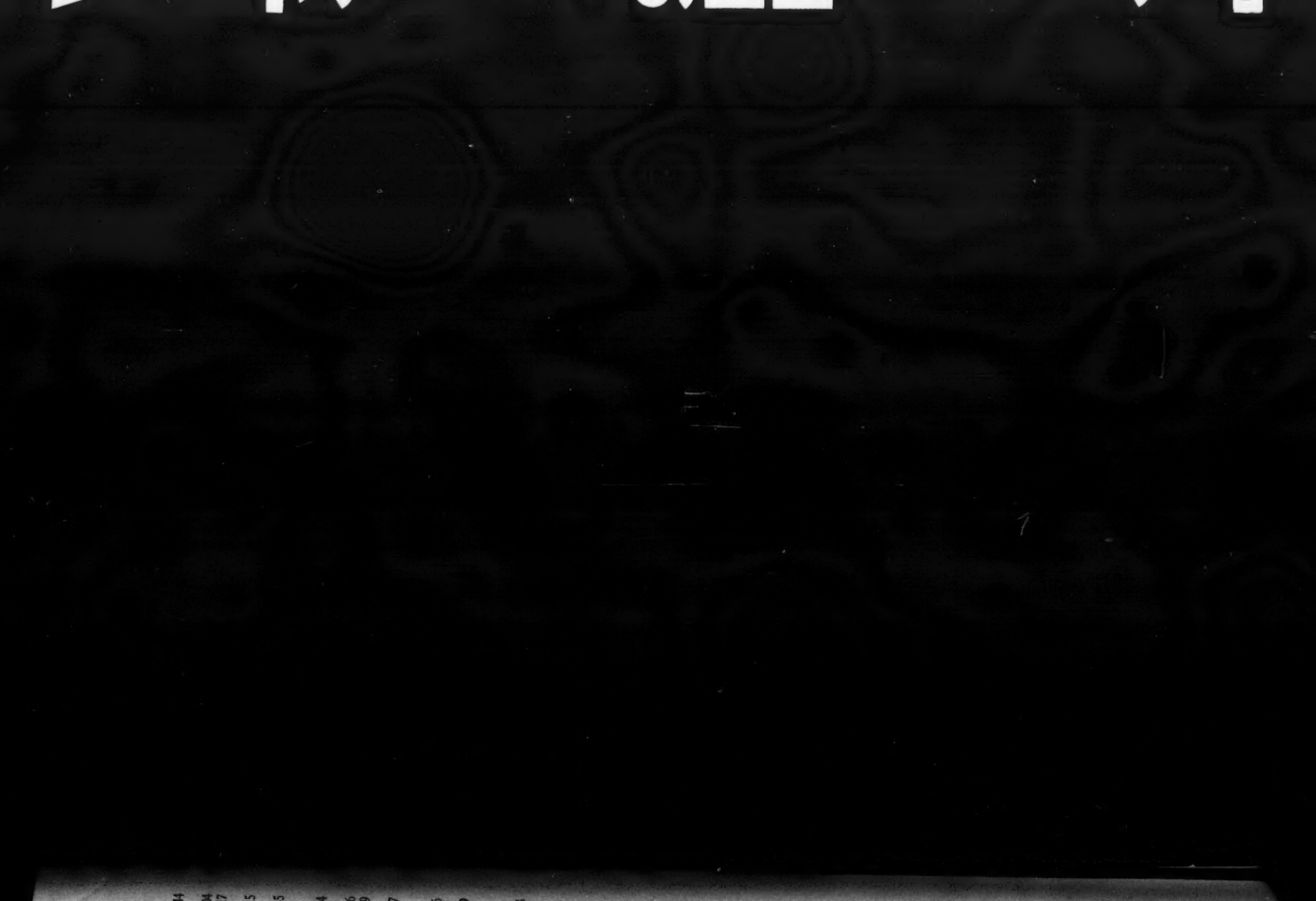
FOX, L. WEBSTER. Foreign Bodies in the Eye.... 626

FRAWLEY, JOHN M. Ultra-violet Light in California Summer Sunshine, with Special Reference to Its Value in the Prophylaxis and Treatment of Rickets..... 644

FREUND, LEOPOLD. Radiation Treatment of Diseases of the Heart..... 635

FRIAUF, JAMES B. Applications of X-rays to the Study of Metals..... 613

GAJEWSKI, H. X-ray Interference by Di- and Tri-atomic Molecules of Light Gases..... 609
GFRÖRER, O., and BERGER, HEINZ. The Determination of the Half Value Layer of Grenz Rays 633
GLOCKER, R. Protective Lead Thickness in the International and in the German Protective Recommendations 611
GOEBEL, LUISE. Radio-active Metamorphic Phenomena in Fluorspar from Wölsendorf..... 610
GRATIAS, O. A. *(with* HARRINGTON, E. L.)..... 614
GRAY, L. H. Scattering of Hard γ-rays. II..... 613
GROSS-ALBENHAUSEN. Osteitis Fibrosa Cystica in the Region of the Hip Joint..... 600
GUDZENT. The Use of Radium in Disturbances of the Internal Secretions, Especially in Basedow's Disease..... 643
HALL, HARVEY. Relativistic Theory of the Photo-electric Effect. Part I.—Theory of the *K*-absorption of X-rays..... 606
HALL, HARVEY, and OPPENHEIMER, J. R. Part II.—Photo-electric Absorption of Ultra-gamma Radiation 606
HALLA, FRANZ. X-ray Distinctions between Magnesite and Dolomite..... 614
HARKAVY, JOSEPH, and MAISEL, FRED. Infectious Asthma and Its Relationship to Chronic Sinus and Pulmonary Disease..... 644
HARRINGTON, E. L. Nature of the Groupings of Radio-active Atoms..... 609
HARRINGTON, E. L., and GRATIAS, O. A. The Formation of Molecular Aggregates in Radon-gas Mixtures Containing Polar Molecules 614
HARTLEB, O. Absorption of Saturated Fatty Acids in the Ultra-violet Region..... 656
HENRICHSEN, KARL J. *(with* SWEANY, H. C., and STADNICHENKO, ASYA)..... 618
HEPBURN, THOMAS N. Necrosis of Ureter, Following Repeated Injections of Mercurochrome and Silver Nitrate Solutions..... 633
HERTEL, EDUARD, and SCHNEIDER, KURT. Comparison of the Crystal Structures of an Addition and a Substitution Compound..... 612
Idem. Polymerization in Crystal Lattice—Crystal Structure of Trinitoresorcinol and Trinitrophloroglucinol 606
HERZOG, R. O., and JANCKE, W. Note on the Roentgen Diagram of Collagen (Fiber Period) 608
HESS, ALFRED F., and SMITH, PHILIP E. Excessive Ultra-violet Irradiation: Effect on the Nutrition and the Endocrine Glands of Rats 656
HODGSON, JOHN S. Craniocerebral Injuries..... 646
HOFFMANN, JOSEF. Discoloration of Glass and Some Minerals by Beta and Gamma Rays..... 614
HOFFNER, KARL. Successful Treatment of Roentgen Injuries by Under-water Massage 645
HULLSIEK, RICHARD B. Spontaneous Rupture of the Kidney: Report of a Case..... 636
IDEI, SAKAE. The Fine Structure of the *K*-absorption Spectrum of Selenium..... 611
Idem. The Fine Structure of the Moseley Curves for the Energy Levels in the Lower Elements 610
Idem. The Fine Structure of the Moseley Curves for the *M*-absorption Edges in the Heavier Elements 611
Idem. The Precise Measurements of the L-group of the X-rays in the Heavy Elements.. 610
Idem. The Regularities of X-ray Spark Spectra 612
ILLICK, H. EARL *(with* STEWART, WILLIAM H.)..... 621
ILLIG, WERNER. The Duration of the Roentgenologic Demonstrability of Cranial Fractures during Childhood 647
JACOBAEUS, H. C., and WESTERMARK, N. A Further Study of Massive Collapse of the Lung 617
JANCKE, W. *(with* HERZOG, R. O.)..... 608
JANES, ROBERT M. Repair of Diaphragmatic Hernia with Fascia Lata..... 622
JAUNCEY, G. E. M. The Scattering of X-rays by Gases and Crystals..... 637
JENKINSON, E. L., and ELLIS, I. G. Roentgen Significance of Gas under the Diaphragm. Unusual Case with Discussion..... 655
JOHNSON, THOMAS H. Diffraction of Hydrogen Atoms 640
JONES, THOMAS E. A Comparison of the Results of Surgery and of Radiation in the Treatment of Cancer of the Cervix: Analysis of 200 Cases Subjected to Radiation Treatment 605
KADRNKA, SILVIJE. Hepatosplenography: Radiologic Method of Examination of the Hepatic and Splenetic Parenchyma by Intravenous Injection of Thorotrast, a Colloidal Substance with a Thorium Dioxide Base..... 620
KAPLAN, IRA I. The Emergency Value of Roentgen Therapy in Pediatrics..... 644
KARLIK, BERTA. Experiments on the Luminescence of Zinc Sulphide and Diamond under the Influence of Radio-active Radiation..... 615
KATZ, J. R., and DERKSEN, J. C. An Explanation of the Swelling Effect of Thiocyanates on Cellulose: Compounds of Cellulose with Neutral Salts 615
KAUFMAN, LOUIS RENE. The Use of the Cystoscope in Tuberculosis of the Bladder..... 653
KEYES, E. LAWRENCE. Bilateral Empyema of the Pleural Cavities 619
KHASTGIR, S. R. The Absorption of Scattered X-rays and Compton's Theory of Scattering 607
Idem. A Note on the Relative Absorption of the Primary and Scattered X-rays by Silver and Tin..... 609
KLINE, LANE B. Outline of the Diagnosis and Treatment of Intestinal Tuberculosis..... 650
KOCH, SUMNER L. *(with* MASON, MICHAEL L.)..... 602
KRAUSE, ALLEN K. Chronic Pulmonary Infections in Childhood..... 652
LABEAU *(with* BERTRAND). Radiotherapy in the Treatment of Angina Pectoris..... 635
LAMBRANZI, MARIO. Radiologic Appearance of Pulmonary Tuberculosis Associated with Surgical Tuberculosis..... 651
LAUREATI, L. Febrile Symptoms in Carcinoma of the Colon..... 604
LEE, HAROLD G. Fractures of the Tuberosities of the Tibia..... 601
LINDEMULDER, F. G. Subdural Hematoma Shown by Encephalography..... 654
LINKE, F. The Importance of the Aperture in Actinometers for Measuring Sun and Sky Radiation 639
LOBEN, FRANZ. The Main Roentgenologic Types of Lung Tuberculosis and Their Differential Diagnosis, with Special Consideration of New Developments in Clinical and Pathologic Anatomy..... 652
LOVISATTI, NICOLA. Study of the Esophagus in Diseases of the Heart and Aorta..... 635
LUCRI, TITO. The Pyelographic Diagnosis of Renal Tumors by Retrograde Pyelography.... 631

McClure, H. I. (*with* Allen, F. M. B.) 647
McCrae, George W. An X-ray Study of Mannitol 615
McIntyre, H. D. Diagnosis of Brain Tumor 603
McPherson, S. H. (*with* Swett, Paul P., and Pike, M. M.) 600
Mack, H. C., and Catherwood, A. E. The Aschheim-Zondek Reaction in Hydatidiform Mole and Malignant Chorionepithelioma 634
Maisel, Fred (*with* Harkavy, Joseph) 644
Mangan, H. A., and Schlundt, Herman. A Spinthariscope for Measuring Radio-activity 599
Marbach, Karl. The Question of the Disturbance of the Equilibrium between Radium B and Radium C in Preparations Freed from Residual Emanation 613
Martius, Heinrich. About the Radiation Therapy of Uterine Myomas 634
Mason, Michael L., and Koch, Sumner L. Human Bite Infections of the Hand, with a Study of the Routes of Extension of Infection from the Dorsum of the Hand 602
Mather, J. H. Progressive Myositis Ossificans 640
Mathews, Robert F. Symptoms and Diagnosis of Stones in the Urinary Tract 632
Mathieu (*with* Desmaroux) 609
Idem 607
Meller, Oskar. A Contribution to the Knowledge of the Lymphatic System of the Lung: An Anatomic-roentgenologic Study 621
Merritt, Edwin A. Mixed Tumors of the Parotid Gland 655
Miles, Frank D., and Craik, James. II.—The X-ray Examination of Nitroramie 616
Miller, Oscar Lee. Plastic Bone Repair after Therapeutic Irradiation: Report of a Case 601
Mörikofer, W. (*with* van Wyk, A., and Reerink, E. H.) 616
Moxnes, N. H. Quantitative Chemical Analysis by Means of the Absorption of X-rays 616
Muir, Joseph. Improved Method of Implanting Radon Seeds 642
Mulsow, Frederick W. Roentgen Carcinoma and Sarcoma of Man, with Report of a Case 645
Muskat, Morris. The Anomalous Scattering of Alpha-rays 638
Nagy, L. J. X-ray Dispersion in Copper Sulphate Crystals 610
Nasini, A., and Natta, G. The Crystal Structure of the Inert Gases. II.—Krypton 612
Natorp, W. Pedunculated Polyp of the Stomach 629
Natta, G. The Structure of Hydrogen Sulphide and Hydrogen Selenide 614
Natta, G. (*with* Nasini, A.) 612
Noble, T. P. Dyschondroplasia 602
O'Brien, Frederick W. Kümmell's Disease 647
O'Leary, Austin J. Interaction of X-rays with Bound Electrons 637
Oppenheimer, J. R. (*with* Hall, Harvey) 606
Parker, Marian E. (*with* Pinner, Max) 653
Peck, Willis S. Application of Physical Therapy Measures in the Treatment of Burns 641
Pike, M. M. (*with* Swett, Paul P., and McPherson, S. H.) 600
Pinner, Max, and Parker, Marian E. The Cavity in Pulmonary Tuberculosis 653
Publication Committee of the *Canadian Medical Association Journal*. Physiotherapy: Modus Operandi 641
Rabinowitsch, A. M. A Contribution to the Diagnosis of Thymomas 649
Reerink, E. H. (*with* van Wyk, A., and Mörikofer, W.) 616
Reilly, William Anthony. Hypertelorism: Report of Four Cases 646
Renander, Axel. Cases of Roentgenologically Studied Gastric Tuberculosis 651
Ritvo, Max (*with* Butler, P. F.) 628
Rogers, A. J. The Roentgen Ray in Dental Practice. 622
Sandera, Robert. Significance and Evaluation of the Transverse Folds of the Canalis Egestorius as a Disease Symptom 627
Sanford, Shelton P. Thoracic Aneurysm: Statistical Study of Seventy-one Cases 625
Santoro, Angelo. A Case of Osteitis Fibrosa Cystica Associated with Paget's Disease of the Skull 602
Santoro, Mario. Death after Intravenous Pyelography. 633
Idem. Pneumo-ventriculography in Two Cases of Cerebral Affections 603
Sarkar, A. N. X-ray Examination of the Crystal Structure of Resorcinol 615
Satta, Francesco. Perforating Caries of the Ileum with Transparietal Flow Caused by Intra-pelvic Abscess of the Gluteal Region. 650
Schlundt, Herman (*with* Mangan, H. A.) 599
Schneider, Kurt (*with* Hertel, Eduard) 612
Idem 606
Schwartz, Joseph. Crochet Needle in the Bladder, with Secondary Perforation 626
Scott, S. Gilbert. Diverticula of the Duodenum. 630
Seel, Hans, and Dannmeyer, F. The Isolation and the Chemo-physical Nature of Vitamin A 656
Sepke, G. Ultra-violet Radiation in Tuberculosis of the Lungs 654
Shannon, E. H. The Azygos Lobe of the Lung 617
Shnayerson, Ned. A New Endovesical Instrument. 599
Silvers, Lewis J. Electrothermic Extirpation of Tonsils; The End-results with a Newer Technic. 649
Skobeltzyn, D. (*with* Ellis, C. D.) 608
Smith, Arthur, L. Configuration of the Heart in Cardiac Disease. 635
Smith, Frank R. Etiologic Factors in Carcinoma of the Cervix 605
Smith, Philip E. (*with* Hess, Alfred F.) 656
Spence, Hugh S. Radium-bearing Minerals from Great Bear Lake, Northwest Territories. 613
Sproull, John. A Discussion of the Occurrence of Benign Ulcer of the Greater Curvature. 655
Sptizuin, V. I. The Mechanism of Separation of Radon from Radio-active Minerals in Liquid Medium 607
Stadnichenko, Asya (*with* Sweany, H. C., and Henrichsen, Karl J.) 618
Stewart, William H., and Illick, H. Earl. Oral Cholecystography: Fundamentals of Technic and Interpretation 621
Sulger, E. On the Influence of the Incubating Time of a Bacterial Culture on its Susceptibility to Roentgen Rays 600
Swan, Channing S. Cancer of the Prostate 603
Sweany, H. C., Stadnichenko, Asya, and Henrichsen, Karl J. Multiple Pulmonary Abscesses Simulating Tuberculosis, Caused by the Friedländer Bacillus 618

SWETT, PAUL P., MCPHERSON, S. H., and PIKE, M. M. Fracture of the Tibia into the Knee Joint. 600
TERREY, HENRY, and BARRETT, ERIC GEORGE VICTORY. Quantitative X-ray Analysis. Copper-silver and Copper-zinc Alloys..... 608
TURNBULL, D. J. Polycystic Kidneys..... 636
TURNBULL, HURBERT M. (*with* YOUNG, MATTHEW). 648
TURNER, W. E. S. Effect on the Properties of Soda-lime-silica Glass of Repeated Melting in Platinum. The X-ray Pattern..... 613
VALLEBONA, ALESSANDRO. A Modified Technic of Radiographic Dissociation of Shadows Applied to the Study of the Skull..... 647
VALLEBONA, ALESSANDRO, and CAPOCACCIA, MARIO. Further Observations on the Effect of X-rays on Tissues of Mesenchymal Origin. 600
VAN DER TUUK, J. H., and BOLDINGH, W. H. Protective Lead Thickness in the German Protective Recommendations 611
VAN WYK, A., REERINK, E. H., and MÖRIKOFER, W. Sun Rays and Vitamin D..... 616
VISHER, J. W. Pyelography with Emulsified Campiodol. 621
WAGNER, HANS. Hydroxide Systems in Iron Oxide Colors. 612
WEBSTER, J. H. DOUGLAS. Ovarian and Testicular Cancers: Their Response to X-ray Treatment. 644
WESSON, MILEY B. Carcinoma of the Prostate: Unusual Metastases, ... 604
WESTERMARK, N. (*with* JACOBAEUS, H. C.)..... 617
WICK, FRANCES G. Experiments on Radiothermoluminescence. 615
WISHART, D. E. S. The Diagnosis of Mastoiditis in Children..... 645
WITT, FRANZISKA. The Distribution of Radon between Liquid and Solid Phases of Water and of Benzene..... 614
WOLLAN, E. O. Experimental Electron Distributions in Atoms of Monatomic Gases..... 616
IDEM. Scattering of X-rays from Gases..... 639
WOO, Y. H. Temperature and Diffuse Scattering of X-rays from Crystals..... 637
WRIGHT, HAROLD E. A Study of the Comparative Values of the Oral and Intravenous Methods of Gall-bladder Visualization..... 626
YAMAMOTO, TOSHIMICHI (*with* CHIKASHIGE, MASUMI). 609
YOUNG, MATTHEW, and TURNBULL, HURBERT M. An Analysis of the Data Collected by the Status Lymphaticus Investigation Committee. 648